MACHINE DESIGN

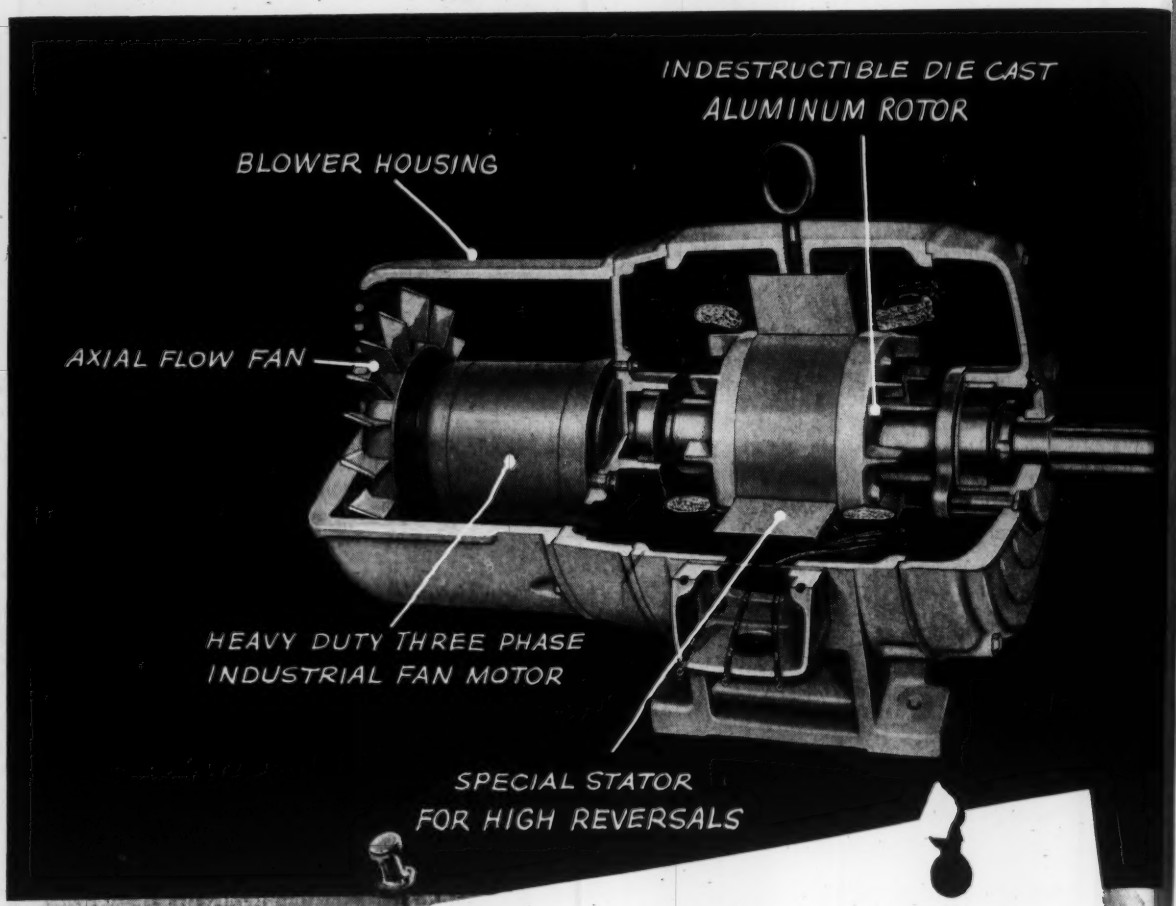
A PENTON PUBLICATION

JANUARY 12, 1956

621

JAN 16

Now... Every Other Week



212 idle reversals per minute*

Special blower assembly continuously cools Louis Allis rapid-reversing motors, to permit high rate of reversals

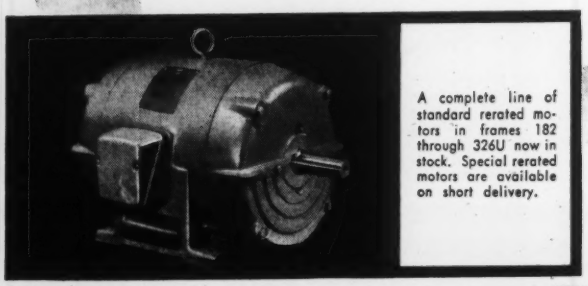
Here's a motor built especially to withstand the tough demands of rapid reversal applications. It is kept cool by its own integrally mounted blower that forces cooling air through the motor and over the windings and end rings.

Other factors that lead to long dependable motor life are: Large stator slots and special slot shapes that allow maximum copper in the windings. Specially annealed and coated lamination steel that reduces losses and increases the number of reversals possible. New Phenolic impregnating varnish that protects the insulation with outstanding thermal and chemical resistance for Class A insulation. Also built with Class B and H insulation.

These reversing motors meet standard NEMA mounting dimensions except for the increased length caused by the addition of the blower. And you can get constant torque or constant horsepower ratings in single and multiple windings for two or more speeds. Sizes range from 1/2 to 15 hp. See your Louis Allis field engineer for complete information about this remarkable new motor development.

Send for bulletin 1800 describing these new motors.

*3 HP, 1200 RPM with Class H Insulation



A complete line of standard rerated motors in frames 182 through 326U now in stock. Special rerated motors are available on short delivery.

THE LOUIS ALLIS C
MILWAUKEE 7, WISCONSIN

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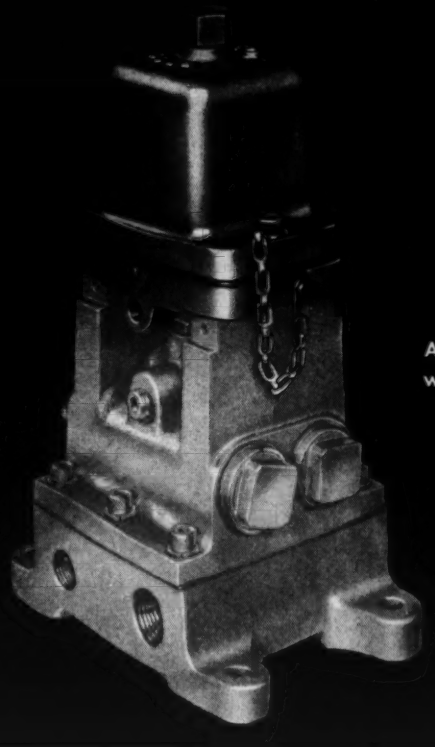
new JIC Solenoid and Cover!



Available on 700 Series Ross Air Valves when specified or may be installed on valves now in your plant.

- Cover protects solenoid against dust, splashing liquids and airborne contaminations.
- Can be manually operated without removing cover.
- Ample wiring connection space.
- Ring type pressure connectors.
- Interchangeable with standard Ross cover and solenoid.
- Valve becomes electrically inoperative when cover is removed.
- Captive type cover fasteners.
- Chain to prevent loss of cover.
- Threaded electrical conduit connection.
- Provision for piped exhaust.

- JIC Solenoid Cover and Head Assembly also available for 700 Series Momentary Valves.

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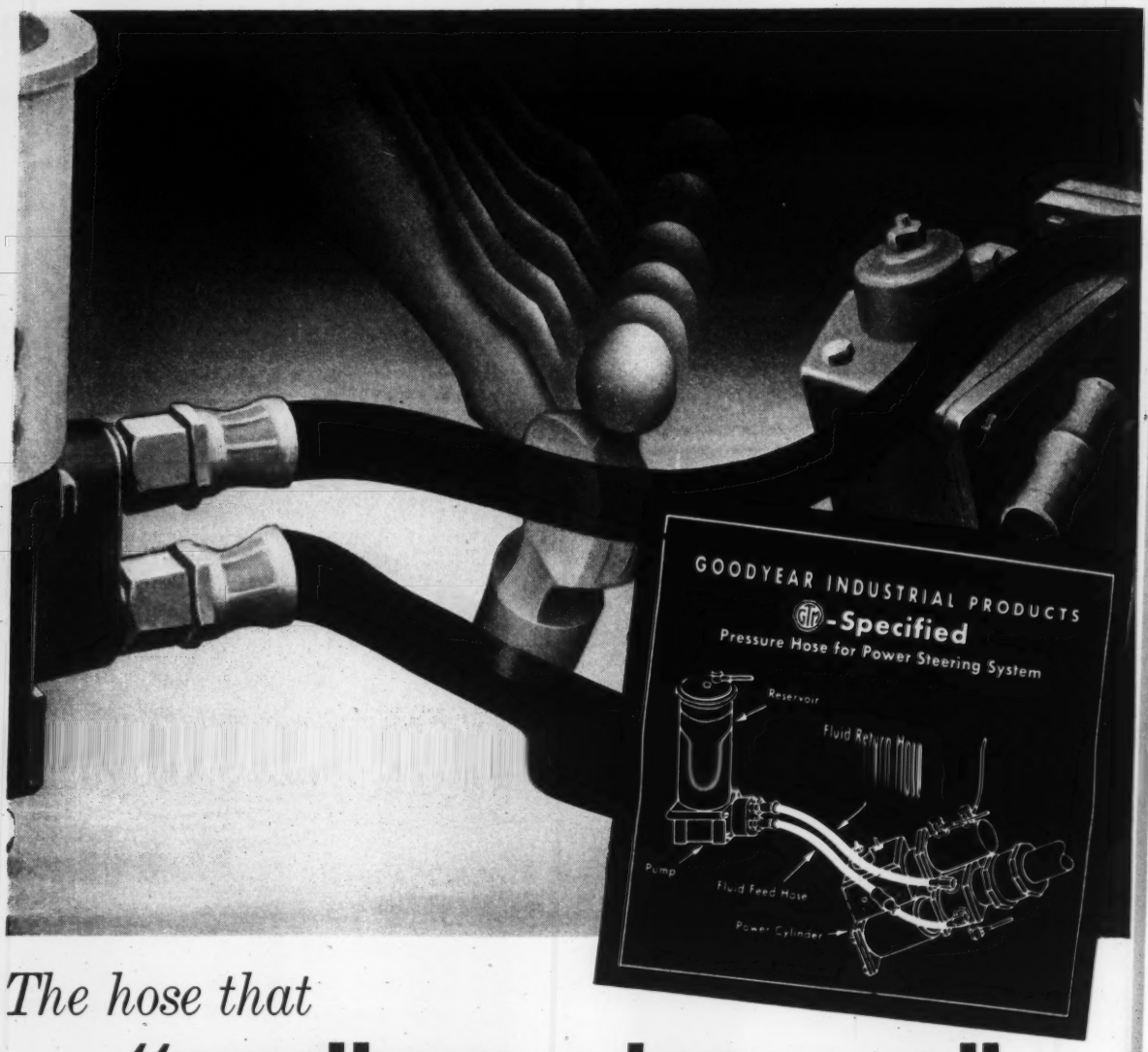

The hose that

"swallows a hammer"

–to make power steering possible

MANY were the headaches in the development of power steering. One big problem was to eliminate the excessive vibration and noise from the first trial units. Rapid changes of high pressures were the cause. Steel pressure accumulators were a solution, but they were too high in cost and maintenance.

Then, someone thought of hose. They tried common water hose. Over a hundred feet was needed–far too much to put under an automobile. Shorter lengths of every possible type were tried without success. Finally, the G.T.M.–Goodyear Technical Man–was called in.

His answer was a special hose that withstood the over 600 pounds' pressure; that expanded between certain pressures to absorb the "Hammer"; that resisted engine-heat, oil, grease and hydraulic fluid – all in a mere *18 inches'* length. The result was practical power steering. What can he do for you?

You can consult the G.T.M. through your Goodyear Distributor or by writing Goodyear, Industrial Products Division, Akron 16, Ohio.

YOUR GOODYEAR DISTRIBUTOR *can quickly supply you with Hose, Flat Belts, V-Belts, Packing or Rolls. Look for him in the yellow pages of your Telephone Directory under "Rubber Products" or "Rubber Goods."*

GOODYEAR

THE GREATEST NAME IN RUBBER

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THE PROFESSIONAL JOURNAL
FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

JANUARY 12, 1956
Volume 28—No. 1

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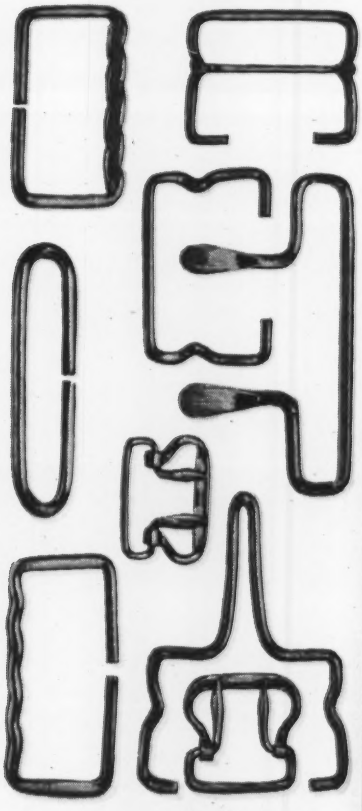
LG21.051
M183

Anaconda Wire now available in New Pay-off Container



BUCKLES AND BUCKLE PARTS made by West Haven Buckle Co., West Haven, Conn., using Anaconda 70-30 yellow brass wire. Finished buckles, later nickel plated, are of highest quality, noncorroding, for use in surgical bandages, trusses, corsets and other surgical appliances.

Shutdowns to change coils in wire forming machines cut 90% at West Haven Buckle Company

The West Haven Buckle Company of West Haven, Conn., used to be limited to relatively light coils of brass wire because of the slide feed necessary for free pay-off into its wire forming machines. Machines could operate less than an hour before shutdown to feed in another coil.

When they started using Anaconda Wire packaged in the *new pay-off barrel*, which provides free pay-off, the runs were increased 10 times. The big coils of brass wire—400 to 500 pounds—made possible continuous runs of from 8 to 9 hours. This cut the time lost in changing coils 90 per cent. It eliminated the labor of shifting and lifting heavy coils—as the wire is fed directly from the barrel.

An easy way to increase production, cut costs: Big coils of Anaconda Wire in the *new pay-off barrel* give you these advantages:

1. Reduced down-time to change coils can mean production increases up to 25 per cent. Free pay-off feature may enable you to increase machine speed for still greater production.
2. Operators are freed for other duties during the longer continuous runs.
3. Easier handling, better inventory control. Barrels are clearly marked for quick identification—are easily handled by standard hand trucks—utilize storage space efficiently—can be stacked. Losses are minimized because coils stay clean indefinitely—there is no danger of coils becoming tangled or mixed.

No extra charge for Anaconda Wire in the new pay-off container. Call your American Brass Company representative today or write: The American Brass Company, Waterbury 20, Conn. 5585

THE NEW CONTAINER which provides Anaconda Wire in 400 to 500 pound coils, ready for free pay-off into pin machines and other automatic forming machinery. Anaconda wire in all alloys is available packaged this way for long, continuous runs—in all gages up to .090", in tempers at least one number hard.

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COPPER AND COPPER ALLOY WIRE

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Engineering News Roundup

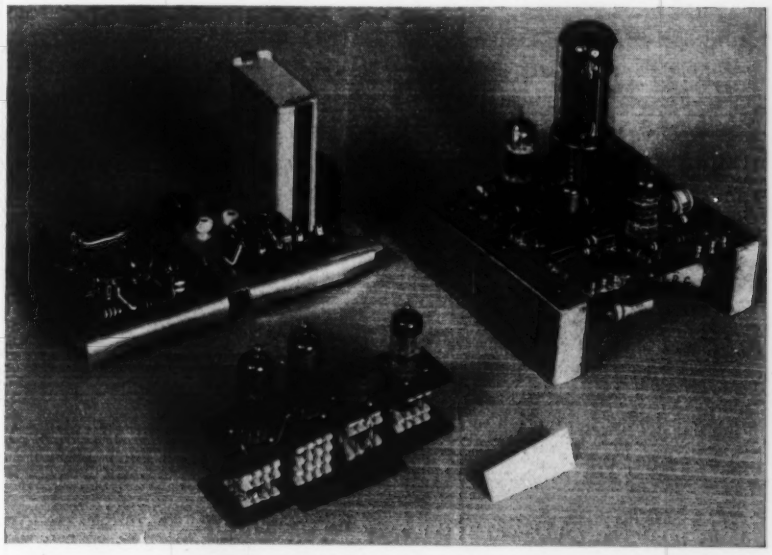
Savings Expected from NBS Preferred Circuits Study

Standardization of Power Type Most Promising

WASHINGTON, D. C. — The National Bureau of Standards has found that it is feasible to standardize many of the electronic circuits used in Navy aeronautical equipment. A standardization program, undertaken for the Navy Bureau of Aeronautics, is seeking to determine those well-known circuit configurations that are common to a wide variety of electronic devices but which now differ in detail. Known as the NBS-BuAer preferred circuits program, this continuing investigation may result in important economies in critical engineering man-hours, in lead time, and by accelerating production.

The program seeks also to provide the military services with means for (1) simplifying maintenance training, (2) designing simple "throw-away" units, (3) achieving improved operational reliability, and (4) establishing design standard levels. The Bureau is cooperating with industrial groups engaged in similar programs through exchange of information.

The over-all circuit of any aeronautical electronic equipment is extremely complex. It is a composite of many individual smaller circuits, most of which are known and used in different combinations in other equipment having other functions. Most aeronautical electronic equipment includes rectifier circuits, and many include amplifier circuits and timing circuits.



Preferred circuits currently studied by the National Bureau of Standards are readily adaptable to different construction methods, including mechanized production, printed circuitry, or laboratory breadboard techniques. Shown here are three different preferred circuits built by these different techniques

Such widely used subcircuits are the essential building blocks of the overall design.

Although many of these electronic building blocks have become widely accepted for their general function and circuit arrangement, no attempt has been made to standardize their exact circuit configurations or the resistance or capacitance values of their components. One of the great advantages of electronic techniques is the flexibility of the circuits which electronic engineers are naturally reluctant to surrender. Nevertheless, preliminary consideration by the Bureau of Aeronautics and a feasibility study by NBS showed that the standardization of circuits used in aeronautical electronic equipment should result in worthwhile advantages.

The initial feasibility study consisted of a detailed examination of 22 carefully selected items of aeronautical electronic equipment. The results showed that the over-all circuits of the 22 equipments essentially were made up of 60 circuit types and that 50 to 70 per cent of the cathodes were standardizable. It was also found that the voltages used in 20 equipments showed 20 different nominal values which appeared readily reducible to four.

Our Front Cover

Introducing our new publishing frequency, George Farnsworth's cover theme this month is "26 in '56." In 1956, *Machine Design* will be published every other week—26 issues a year. More details can be found on the Editorial page.

Rounding Up the 1956 Automobiles—3

THE seven cars reported this month complete the list of 1956 models. Like the cars reported previously, they feature more powerful engines than corresponding 1955 models. Emphasizing their concern for passenger safety, the manufacturers point out the sturdy construction of their car bodies, padding on internal projections and optional safety belts.

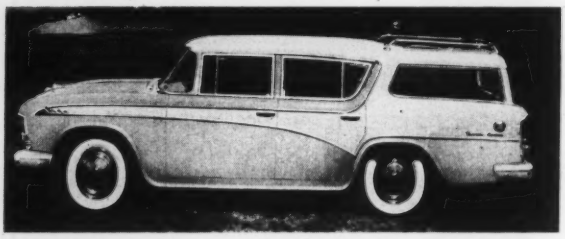
Contours of the new models show the influence of current jet aircraft design. The variety of colors available should satisfy any new car customer. Many lines offer record numbers of two-tone combinations, and several offer a choice of three-tone styles.

Rambler is still the smallest American car and claims corresponding operating economies. Studebakers are more bulky without increase of overall dimensions and provide a choice of five engines. Pontiac's main feature is modern styling. Oldsmobile provides a new transmission claimed to be smoother operating. Hudson offers 6 and 8-cylinder engines with four different transmissions. Chevrolet lines offer numerous combinations of style and mechanical elements in the effort to duplicate past sales records.

Pushbutton gear changes are less common in these seven makes than 12-volt electrical systems. Many models can receive multiple carburetors to increase engine power. Accessories like power steering, power seats and power window lifts are optional in most lines.

RAMBLER

The 1956 Rambler line includes seven styles of four basic four-door models—a sedan, hardtop convertible, station wagon and hardtop convertible station wagon. These are available in a choice of 14



solid colors, 15 two-tone combinations, and 6 three-tone combinations. A feature of both station wagon models is a full-width rear window which rolls down into the tail-gate. With the window lowered, the single tail-gate completely opens the cargo compartment.

In two of the three outside dimensions, 1956 Ramblers are smaller than their predecessors. The new cars are lower and narrower.

Engine Specifications

Type	OHV, In-Line
No. cyls.	6
Bore & stroke (in.)	3⅛ x 4¼
Displ. (in.³)	195.6
Comp. ratio	7.47 to 1
Bhp, max	120 @ 4200
Torque, max (lb-ft)	170 @ 1600

Size and Weight

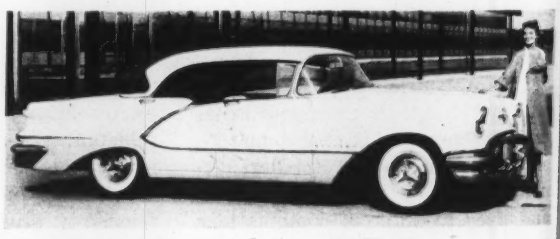
Wheelbase (in.)	108
Length (in.)	191.14
Width (in.)	71.32
Height (in.)	58.0
Weight (lb) (Deluxe Sedan)	2891

A new engine powers the 1956 Ramblers. It provides 33 per cent more power than the former engine, has aluminum pistons with four rings, a forged four-bearing crankshaft, and does not require premium fuel.

Claimed to be the strongest and safest in the industry, the Rambler body and frame are a single, all-welded unit. Provisions for an air-conditioning system are said to be integrated with the basic design of the body shell. Additional safety is provided by 50 per cent greater effective braking area. Power brakes are standard equipment on custom models.

OLDSMOBILE

For 1956, Oldsmobile offers three series of cars in 13 body styles. Four styles are in the "98" series, five in the Super "88" series, and four in the "88" series. Finishes include 155 two-tone color combinations, 19 solid colors and 62 choices of upholstery. Three types of styling are available in the two-tone combinations.



Jetaway Hydra-Matic Drive is introduced in 1956 Oldsmobiles as standard equipment on the "98" series. A second fluid coupling in the Jetaway drive train makes the change of gear ratios in automatic shift-

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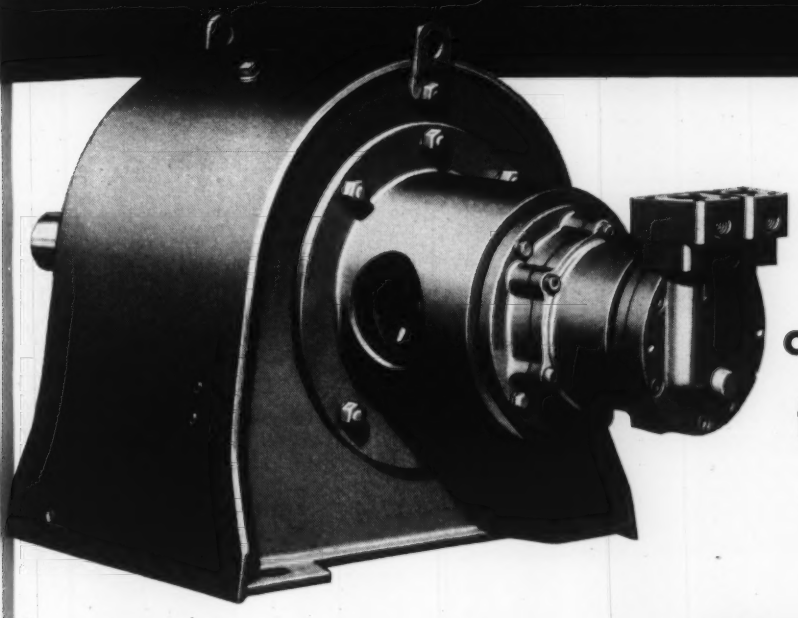
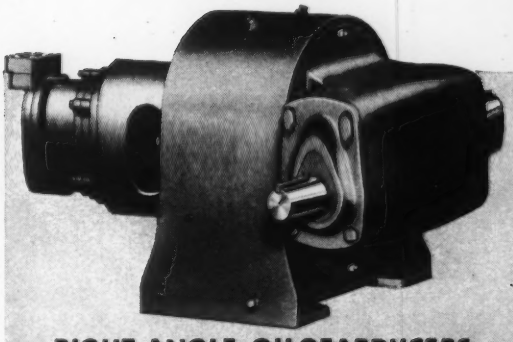
NOW! NEW OILGEARDUCERS



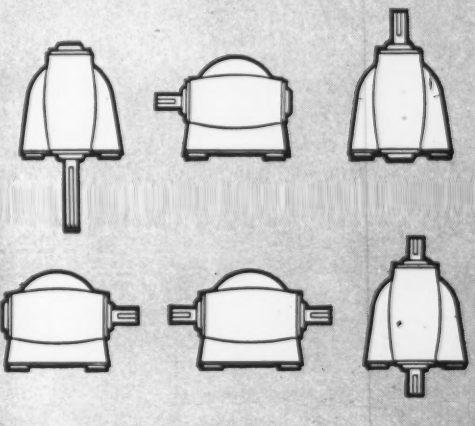
Offering for the first time compact, packaged, fluid power output drive units!

● Oilgearducers are new integral output drive units combining Oilgear Fluid Power axial piston motors and Falk All-Steel Reducers. There are horizontal and vertical models, concentric and right angle types and single, double, triple and quadruple reduction. Now, for the first time you can get a complete, easy to install, "ANY-SPEED" output unit for your high torque, low maximum speed drives. When used in combination with Oilgear Fluid Power Pumps, these reversible Oilgearducers provide infinite variability of speed, absolutely controlled rate of acceleration and deceleration, smooth and swift reversal, cushioned braking. All these together with major economies in motor, circuitry and power requirements. This new Oilgearducer "Any-Speed" output unit is available in sizes from 1 to 20 h.p. It is unequalled for applications as diverse as can-filling, paper machines, centrifugals, cable wrappers . . . and in automation or feed back applications where synchronization is an absolute necessity. Write now for new bulletin 56610. THE OILGEAR COMPANY, 1568 West Pierce Street, Milwaukee 4, Wisconsin.



RIGHT ANGLE OILGEARDUCERS

Oilgearducers with right angle output shafts are available in ratios ranging from 5 to 1500: 1. In assemblies shown below.



Write for this new Bulletin 56610

OILGEAR

OILGEAR

PIONEERS...NOW THREE PLANTS FOR FLUID POWER

PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS & VALVES

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ing less noticeable. A parking lock operated with the shift lever is incorporated in the transmission.

In addition to safety features provided by Oldsmobile in past years, the 1956 models offer a safety-

Engine Specifications

	"88"	Super "88" and "98"
Type	OHV, Vee	OHV, Vee
No. cyls.	8	8
Bore & stroke (in.)	3⅞ x 3 7/8	3⅞ x 3 7/8
Displ. (in.³)	324.31	324.31
Comp. ratio	9.25 to 1	9.25 to 1
Bhp, max	230 @ 4400	240 @ 4400
Torque, max (lb-ft)	340 @ 2400	350 @ 2800

Size and Weight

	"88"	Super "88"	"98"
Wheelbase (in.)	122	122	126
Length (in.)	203.29	203.29	212.29
Width (in.)	78.62	78.62	78.62
Height (in.)	60.5	60.5	60.5
Weight (lb) (4-door sedan)	3761	3897	4047

padded instrument panel, power steering, power brakes and interlock door locks. Seat belts are optional.

On the "98" Deluxe Holiday Coupe, Oldsmobile offers an automatic six-way power seat. In addition to its adjustable features, the seat moves rearward when the door is opened.

CHRYSLER

The 1956 Chryslers offered in the Windsor and the New Yorker lines, are available in a choice of 17 solid colors and 135 color combinations.

The Windsor line includes a four-door hardtop, six-passenger sedan, Nassau hardtop, Newport hardtop, convertible coupe and the Town and Country Wagon. The New Yorker line includes a four-door hardtop, six-passenger sedan, Newport hardtop, St. Regis hardtop, convertible coupe and Town and Country Wagon.

The Chrysler "Forward Look" styling is characterized by fin-like rear fenders said to give an aircraft feeling to the overall design.

Tail lights, stop lights and back-up lights of the 1956 Chrysler have been designed into a single integrated unit protected at the top by a "brow" which juts out from the fender.

For 1956, Chrysler introduces a new pushbutton drive located at the left of the steering column. Only a light touch is needed to change the driving range. A hydraulic interlock prevents the driver from accidentally selecting reverse.

Engine Specifications

	Spitfire	FirePower
Type	OHV-Vee	OHV-Vee
No. cyls.	8	8
Bore & stroke (in.)	3.81 x 3.63	3.94 x 3.63
Displ. (in.³)	331	354
Comp. ratio	8.5 to 1	9.0 to 1
Bhp, max	225 @ 4400	280 @ 4600
Torque, max (lb-ft)	.....	.....

Size and Weight

	Windsor	New Yorker
Wheelbase (in.)	126	126
Length (in.)	220	221
Width (in.)	79	81
Height (in.)	61	61
Weight (lb)	...	...

Chrysler has increased the compression ratio of its Spitfire engine in the Windsor line from 8.0 to 8.5 to one. With modification offered as optional equipment, the Spitfire delivers 250 hp. The FirePower engine in the New Yorker line also has a higher compression ratio.

Chrysler innovations for 1956 include a high-fidelity record player, safety door latches and aircraft-type heater.

CHEVROLET

Chevrolet for 1956 claims continued emphasis on performance and appearance that contributed to record-breaking sales last year. The new models carry increased horsepower, a fleeter, more rugged appearance and are offered in the greatest number of body styles ever produced by Chevrolet. These include a four-door hardtop sport sedan and nine-passenger station wagons.

Body colors range from black to shades of beige and red. Original two-toning gives each of three price series a distinguishing pattern. Ten solids and 14 two-tone combinations are on the 1956 color chart.

The new Chevrolet grille has a lattice-work design, the parking lamps are square, and the gasoline filler is concealed back of the hinged left rear tail lamp.

Six-cylinder production in 1956 will be limited to one 140 hp engine with an 8 to 1 compression ratio.

Engine Specifications

	In-Line	Vee
Type	In-Line	Vee
No. cyls.	6	8
Bore & stroke (in.)	3 7/8 x 3 1/2	3¾ x 3
Displ. (in.³)	235.5	265
Comp. ratio	8.0 to 1	8.0 to 1
Bhp, max	140 @ 4200	162 @ 4400*
Torque, max (lb-ft)	210 @ 2400	257 @ 2200

*170 @ 4400 with Powerglide transmission.

Size and Weight

	Six	Eight
Wheelbase (in.)	115	115
Length (in.)	197.5	197.5
Width (in.)	73.4	73.4
Height (in.)	60.5	60.5
Weight (lb)	3321*	3293*

*4-door sedans with Powerglide transmissions.

Next Page—ITEM 1

Not 25 not 50 not 75 but 100%

of Bound Brook's
skill and experience are
devoted to producing
the world's finest
Powder Metallurgy
Bearings and Parts

BOUND BROOK OIL-LESS BEARING CO., BOUND BROOK, N. J. EST. 1883

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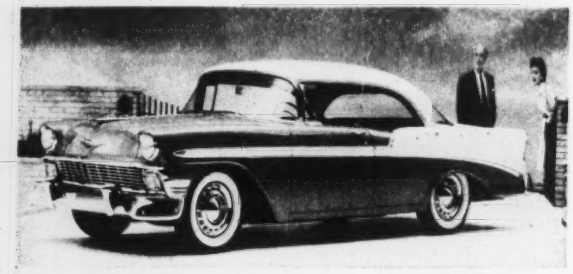
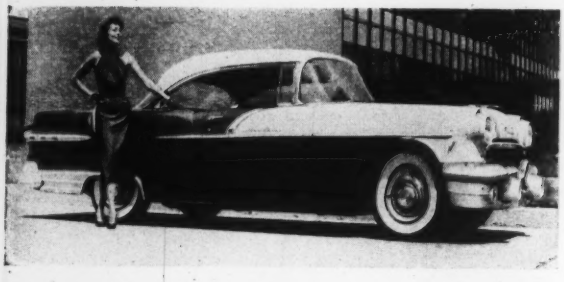


This engine may be used with either the Powerglide automatic transmission or the manual shift. The new engine is said to provide better performance than its predecessors, particularly for highway passing. A choice of V-8 engines is available. One develops 162 hp and is installed in cars with the standard shift. The second is designed for Powerglide and produces 170 hp.

Optional equipment includes overdrive, power steering, power brakes, pushbutton control of seat adjustment, window lifts and air conditioning.

PONTIAC



On Pontiac models for 1956, General Motors introduces a new Hydra-Matic transmission called Strato-Flight Hydra-Matic designed to provide smoother and quieter shifting of gears. Also in 1956, additional power is provided in the Pontiac Strato-Streak engine.

The new models include 15 body styles. Six of these are hardtop Catalinas: three four-door and three two-door. Hardtops are available in all three Pontiac series. A choice of 57 colors are offered in either two-tone or solid styling.

More leg and head room are provided in the front seats of new Pontiacs and a six-way power-adjusted seat is available. Optional equipment includes power steering, power brakes and electric window lifts. Safety door locks are introduced in the 1956 models.

Engine Specifications

	Star Chief Series	860, 870 and Star Chief wagon
Type	OHV, Vee	OHV, Vee
No. cyls.	8	8
Bore & stroke (in.)	3.94 x 3.25	3.94 x 3.25
Displ. (in.^{3})	316.6	316.6
Comp. ratio	8.9 to 1	7.9 to 1*
Bhp. max	227 @ 4800	205 @ 4600*
Torque, max (lb-ft)	312 @ 3000	294 @ 4600*

*For models with Synchromesh Transmission; otherwise same as Star Chief series.

Size and Weight

	Star Chief Series	860, 870 and Star Chief wagon
Wheelbase (in.)	124.0	122.0
Length (in.)	212.6	205.6
Width (in.)	75.1	75.1
Height (in.)	60.5	60.5
Weight (lb)	....	....

STUDEBAKER

Studebaker lines for 1956 include nine sedans, three station wagons and four sports-type models. All the cars have new engines, the most powerful of which is used only in the Golden Hawk sports model. New styling and safety improvements are also featured in all lines.

Engine Specifications

Type	OHV, Vee	OHV, Vee	OHV, Vee
No. cyls.	8	8	8
Bore & stroke (in.)	4 x 3 1/2	3 13/16 x 3 5/8	3 13/16 x 3 5/8
Displ. (in.^{3})	352	289	289
Comp. ratio	9.5 to 1	7.8 to 1	7.8 to 1
Bhp. max	275	210	195
Torque, max (lb-ft)	380 @ 2800	292 @ 2800	286 @ 2800

Type	OHV, Vee	L-Head
No. cyls.	8	6
Bore & stroke (in.)	3 13/16 x 3 1/4	3 x 4 3/8
Displ. (in.^{3})	259.2	185.6
Comp. ratio	7.8 to 1	7.8 to 1
Bhp. max	170	101
Torque, max (lb-ft)	260 @ 2800	152 @ 1800

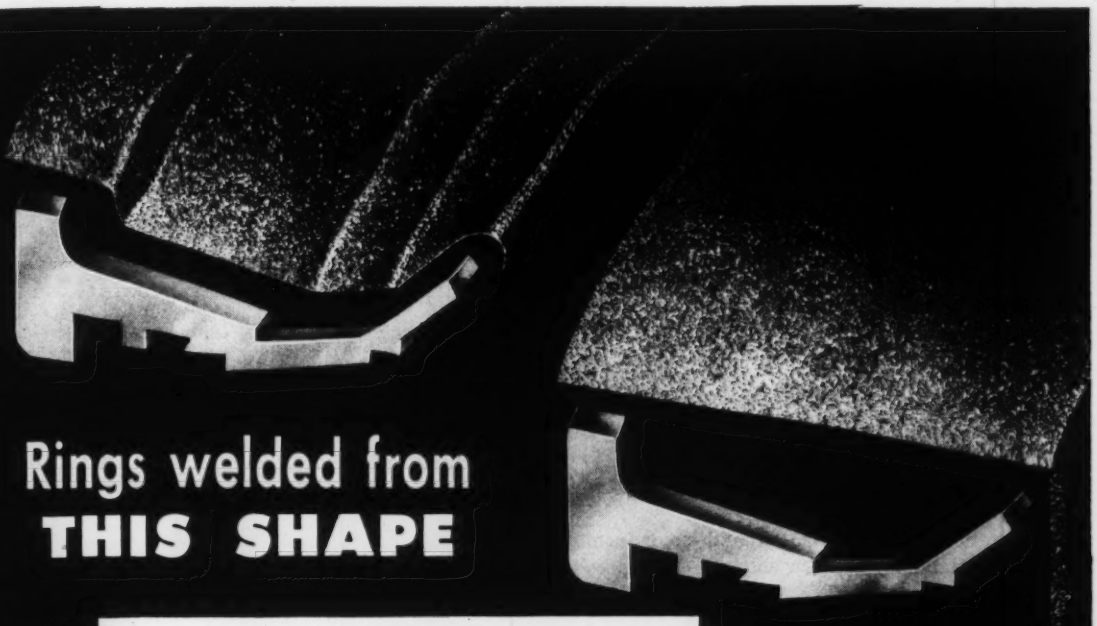
Size and Weight

	Hawk Series	President, Commander and Champion Series
Wheelbase (in.)	120 1/2	116 1/2
Length (in.)	203 13/16	200 3/4
Width (in.)	70 7/8	71 7/8
Height (in.)	56 7/8	60
Weight (lb)	.....	.....

Studebaker hoods and rear decks are higher in 1956 than in the recent past. The new cars are available in 11 solid colors and 23 two-tone combinations with two-tone fabric or vinyl interiors. Sports models have radial dial instruments and a clock with a sweep-second hand.

Safety innovations include a "safety-fin" brake drum said to increase cooling area more than 100 per cent over former designs. A color-lighted speedometer dial has numerals lighted green from 0 to 35 mph, orange from 35 to 60, and red at higher speeds. Safety door latches are standard on all models.

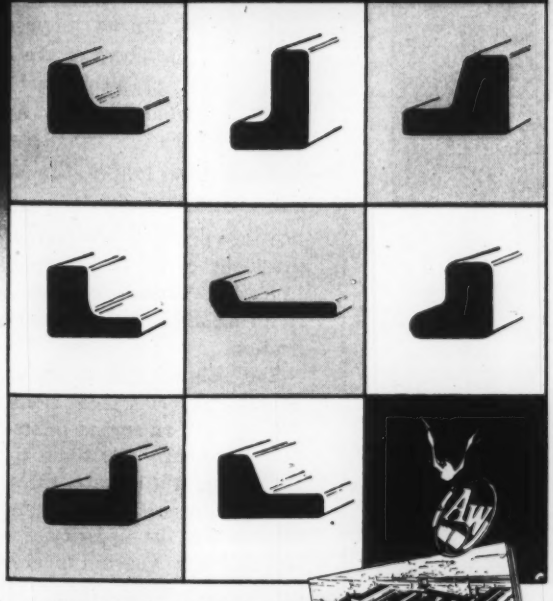
XUM

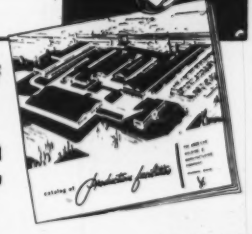


Rings welded from THIS SHAPE

instead of THIS BAR

TYPICAL MILL-ROLLED AND EXTRUDED SHAPES AVAILABLE FROM AMERICAN WELDING





Send for Free Catalog of Production Facilities

Find Out What American Welding Can Do For You

Substitution of a mill-rolled section for a forging previously used, cut the weight of a rough ring 114 lbs. Combined material and machining savings realized in the finished ring amounted to $200.15 per ring —a total of $112,084.00 on a single order.

Economies like this are being effected every day by roll-forming and flash butt-welding of special mill-rolled shapes. Perhaps our Industrial Products Division can help you reduce production costs on similar circular components. Write today for complete information — include blueprints — we will be glad to study your problem.

AMERICAN WELDING

THE AMERICAN WELDING & MFG. CO.
130 DIETZ ROAD • WARREN, OHIO

—ITEM 157—
For More Information Circle Item Number on Yellow Card—page 19

HUDSON

For 1956, Hudson Motors announces new models in the Hornet and Wasp series, featuring new styling and a new 220 hp V-8 engine. The cars include a custom four-door sedan and two-door Hollywood hardtop in the Hornet V-8 series, a super and custom four-door and custom two-door Hollywood hardtop in the Hornet Six series, and a four-door sedan in the Wasp series.

The new dash panel is highlighted by an easy-to-read instrument cluster, featuring a horizontal thermometer-type speedometer centered in front of the driver. The top of the dash panel is lined with a soft crash pad.

A choice of exterior colors and color combinations is available on the new models. Six three-tone combinations are offered for the first time on all Hudson custom models. Also available are 15 two-tone combinations and 14 solid colors.

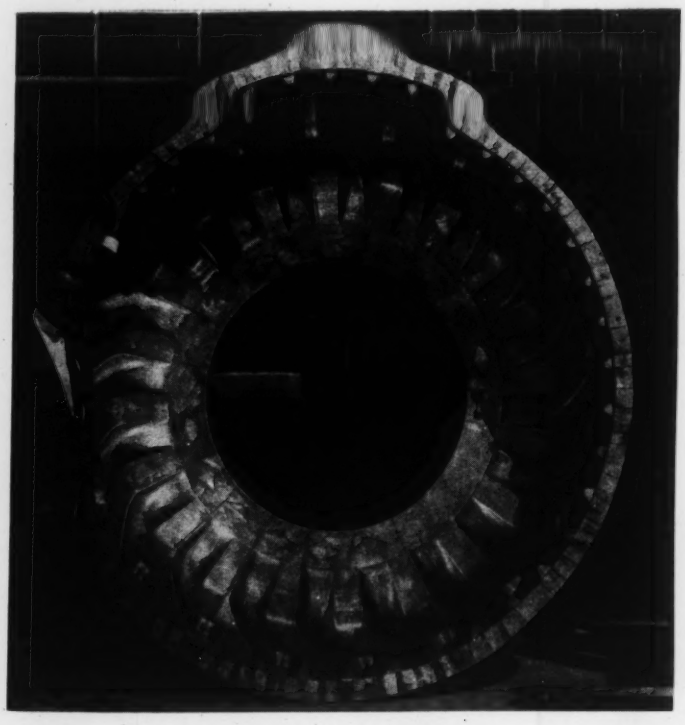
Four transmissions are available on the new Hudson models. Synchromesh transmission is standard equipment on all 1956 models equipped with six-cylinder engines. Automatic overdrive and Dual-Range Hydra-Matic are offered as optional equipment on Hudson Six's. The Twin Ultramatic is available only on Hornet models powered by the new V-8 engine. Power assists, such as power steering, power brakes and power-lift windows, are also available.

Engine Specifications

	Wasp	Hornet-6	Hornet-8
Type	L-head, In-line	L-head, In-line	OHV-Vee
No. cyls.	6	6	8
Bore & stroke (in.)	3 x 4¾	3 1/8 x 4½	4 x 3½
Displ. (in.³)	202	308	352
Comp. ratio	7.5 to 1	7.5 to 1	9.55 to 1
Bhp, max	120 @ 4000	165 @ 3800	220 @ 4600
Torque, max (lb-ft)	158 @ 1400	264 @ 1800	320 @ 2200

Size and Weight

	Wasp	Hornet
Wheelbase (in.)	114¼	121¼
Length (in.)	202¼	209¼
Width (in.)	78	78
Height (in)	61¾	62¼
Weight (lb) (unofficial)	3285	3880



WORLD'S LARGEST cast tire mold is made of aluminum and weighs 1800 lb. Cast by Morris Bean and Co., the mold will be used by Goodyear to make 37.5 by 33 tires for road building equipment

Women Engineers Are Here To Stay

Census Shows

Their Number Grows

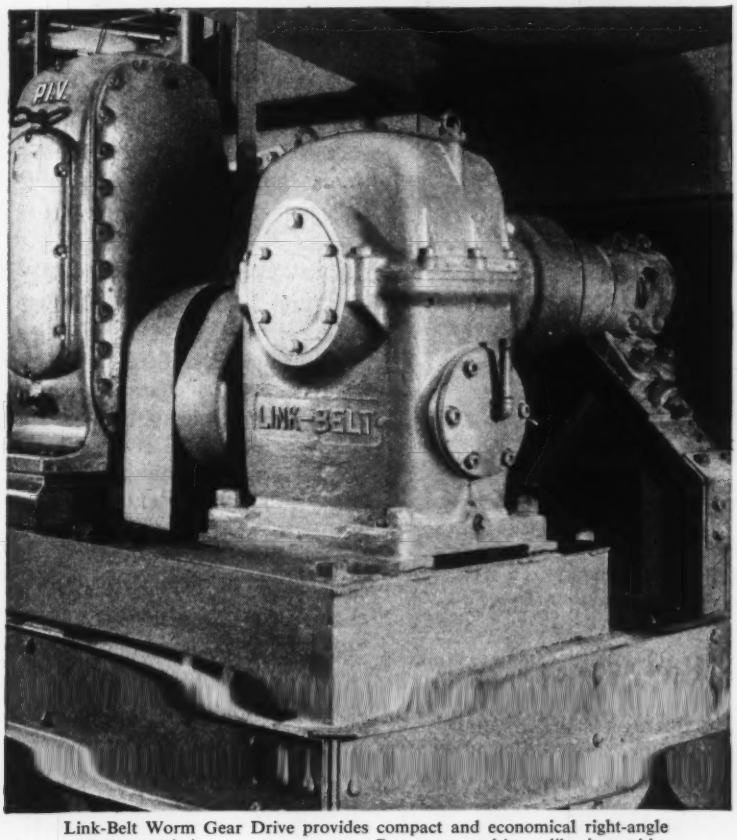
CHICAGO—A woman engineer recently told members of the American Society of Mechanical Engineers that women graduates of engineering schools can help substantially to relieve the current personnel shortages in most engineering fields. Dot Merrill, the president of an engineering sales firm that bears her name, spoke at an ASME Diamond Jubilee celebration.

She pointed out that the 1950 census had classified more than 6000 women as engineers, and that this was nearly five times the corresponding 1940 figure. Mrs. Merrill noted reports from engineering schools that the majority of women enrolled are above the class average scholastically.

Women engineers seem to be accepted particularly in the aviation, electrical and electronics equipment industries, Mrs. Merrill said, although almost every course of

Here's real versatility! LINK-BELT offers you

19 VARIATIONS in WORM GEAR DRIVES



Link-Belt Worm Gear Drive provides compact and economical right-angle power transmission to apron conveyor. Conveyor speed is readily changed by P.I.V. Variable Speed Drive to suit operating conditions.

Meet specific needs from industry's most comprehensive line

WHATEVER the need . . . whatever the speed — Link-Belt Worm Gear Drives can meet your requirements for simple, compact, fixed-ratio speed reduction. With them, you can change the direction and velocity of power . . . match high motor speeds to modern production needs with the least power loss, best possible balance of torque and horsepower ratings.

Choose from a wide selection for fractional or large horsepower requirements. Available with horizontal and vertical housings to permit convenient connections to prime movers and driven machinery.

Single-Worm Gear Drives in ratios from 3.1:1 to 100:1 with output capacities to 97.9 hp.

Helical-Worm Gear Drives in ratios from 26:1 to 540:1 — output capacities to 56.7 hp.

Double-Worm Gear Drives in ratios from 26:1 to 8000:1 — output capacities up to 26 hp and 124,000 inch-pounds torque.

8 of 19 types in the broad Link-Belt line

Type WB—Single reduction, worm below gear, horizontal output shaft.

Type WVS—Single reduction, worm on top of gear, horizontal shaft with screw conveyor flange.

Type HWV—Helical gear first reduction, worm gear final reduction. Vertical output shaft (up or down).

Type HWB—Helical gear first reduction, worm gear final reduction. Worm below gear, horizontal output shaft.

Type WV—Single reduction, vertical output shaft (up or down).

Type DWV—Double worm reduction gear, vertical output shaft (up or down).

Type DWB—Double worm reduction gear, horizontal output shaft.

Type WVT—Single or double reduction overhead conveyor drive.

For full information, consult your local Link-Belt office or authorized stock-carrying distributor. Or write today for Book 2324-A.

LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,948

—ITEM 158—

FLASH DRAINAGE!

Cambridge

WOVEN WIRE CONVEYOR BELTS

permit continuous washing, degreasing, quenching

Open mesh construction permits rapid drainage of process solutions, moving belt eliminates batch handling to provide continuous pickling, quenching, tempering, washing, degreasing. All-metal belt resists corrosion even under the most severe conditions.

In continuous heat treating installations Cambridge Woven Wire Conveyor Belts are impervious to damage at temperatures up to 2100°F. They have no seams, lacers or fasteners to wear more rapidly than the body of the belt . . . no localized weakening. Open mesh construction lets heat and gases circulate freely all around the work for uniform treatment.

No matter how you look at it, CAMBRIDGE Woven Wire Conveyor Belts are invaluable aids to AUTOMATION . . . eliminate profit-stealing batch and hand operations. They are made in any size, mesh or weave, and from any metal or alloy. Special raised edges or cross-mounted flights are available to hold your product during movement.

Here's how a Cambridge belt permits CONTINUOUS WASHING. Stamping and drawing compounds, and metallic particles are washed through open mesh.

Call in your Cambridge Field Engineer to discuss how you can cut processing costs by continuous operation. You can rely on his advice. Write direct or look under "Belting, Mechanical" in your classified telephone book.

ASK FOR FREE 130-PAGE REFERENCE MANUAL illustrating and describing woven wire conveyor belts. Gives mesh specifications, design information and metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

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CAMBRIDGE 1
MARYLAND

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

—ITEM 159—
For More Information Circle Item Number on Yellow Card—page 19

News Roundup

engineering admits women. She suggested that women might ease the current engineer shortage. She decried legislation in many states which makes it impossible for a woman engineer to work more than eight hours a day even when deadlines occasionally make longer work periods necessary.

Magnetic Units May Replace Transistors

NEW YORK — Magnetic amplifiers, another new name on the electronics horizon, are beginning to replace the just - getting - settled transistors in certain computer applications.

A "first," announced by Remington Rand, is an experimental high-speed computer utilizing magnetic amplification principles. Each of the amplifier elements is about the size of a lead-pencil eraser. Called "Ferractors," the units are capable of operating accurately from temperatures as low as −60 to 220 F.

According to Prof. Presper Eckert, inventor of Ferractors, the application of these magnetic units may be the first step toward complete replacement of vacuum tubes and transistors in devices of this type. "Fantastically simple in operation, yet diversified in performance beyond any existing computer of its kind," is the way Eckert sums up the new research development.

Total research time spent on the project amounted to about 5 years, according to Remington Rand. Production plans are presently set up to make the device commercially available in early 1957.

A dry lubricant equally useful as a corrosion preventive was announced recently by the Naval Research Laboratory. Made of Teflon, the new material was applied as a film only a few ten-thousandths inch thick and was found to be effective from −75 to 500 F. In tests lasting eight months, the material was proved a suitable coating for weapons under typical storage conditions. Further experimentation is said to have dem-

onstrated the material's usefulness for machine parts, optical and electronic instruments.

Money-back guarantee is featured by a new beverage-vending machine equipped to collect a bottle deposit and to refund the deposit when the bottle is returned. Made by the German firm of Georg Wiegandt & Soehne in West Berlin, the unit has a capacity of 80 bottles and contains its own refrigerator. To an extent not disclosed, the machine also makes change.

Engine Blocks Are Largest Aluminum Die Castings

Success with In-Line Type Spurs Work on V-8

NEW YORK—Doehler-Jarvis Div. of National Lead Co. announced recently that six-cylinder engine blocks of aluminum have been successfully die cast.

The straight type engine block weighs approximately 50 pounds as it comes from the die-casting machine and 43 pounds when trimmed, and represents the largest die casting ever made in aluminum. The same engine block in gray iron would weigh approximately 175 pounds.

The new block has been produced on an experimental basis at a toledo plant of Doehler-Jarvis on the world's largest die-casting machine. This machine can handle dies weighing up to 50 tons.

Heat conductivity of aluminum is much higher than that of gray iron, and an engine block in aluminum is said to require a less complicated cooling system. It was also claimed that the smooth surface of aluminum die castings prevents the occurrence of uncontrollable sections and sand pockets restricting the flow of cooling water.

The new engine block can be produced at a rate of 30 to 35 pieces per hour on a single machine, according to A. F. Bauer, chief engineer of Doehler-Jarvis. At this rate, approximately 1700

(*Continued on Page 22*)

DRAFTING TRENDS

At the Caterpillar Tractor Co., Joseph Bryant (right) of the Tool Design Department inspects PTM with Marvin Merritt, Frederick Post dealer in Peoria, Illinois.

Improved tracing medium has film-like transparency

Some products remain "news" for several years; usually because their qualities are revolutionary. PTM (Post Tracing Medium) is an excellent example. The transparency, stability and uniform drawing surface far exceed accustomed standards.

The secret of the transparency lies in a patented "welding" process. Special 100% rag paper stock is first impregnated with transparentizing materials. The sheet is then processed under tremendous pressure, literally fusing the materials together into a continuous mass. This produces a sheet no longer resembling paper, but rather a plastic film filled with clear fibers for added strength—a remarkable tracing medium with almost glass-like transparency.

The stability and smooth surface result from the pressure applied during the process. With air pockets eliminated, there are fewer pores in the paper subject to atmospheric changes. PTM offers dimensional stability ordinarily not found in paper based products. The same pressure eliminates all surface variations and traces of grain. PTM provides a smooth, even sheet with uniform drafting performance in every direction ■

New triangle-protractor saves time

A new item called *Ajust-O-Bevel* combines a protractor and a triangle in a single time-saving unit. Biggest innovation is the separate set of graduations for angle or bevel, a scale entirely new in its application to a triangle.

Graduated in 16ths of an inch from 0 to 8", and in 8ths of an inch from 8" to 12", the scale gives a complete variation of sloped lines drawn in inches of drop per foot. It eliminates extra layout and calculating operations with a simple setting.

The hairline (index line) and protractor graduations are on separate, adjacent surfaces to avoid parallax. The *Ajust-O-Bevel* is made of transparent, optical grade plexiglass.

Further information on these items is available from the Reader Service Division of the Frederick Post Company, 3652 N. Avondale Avenue, Chicago 18.

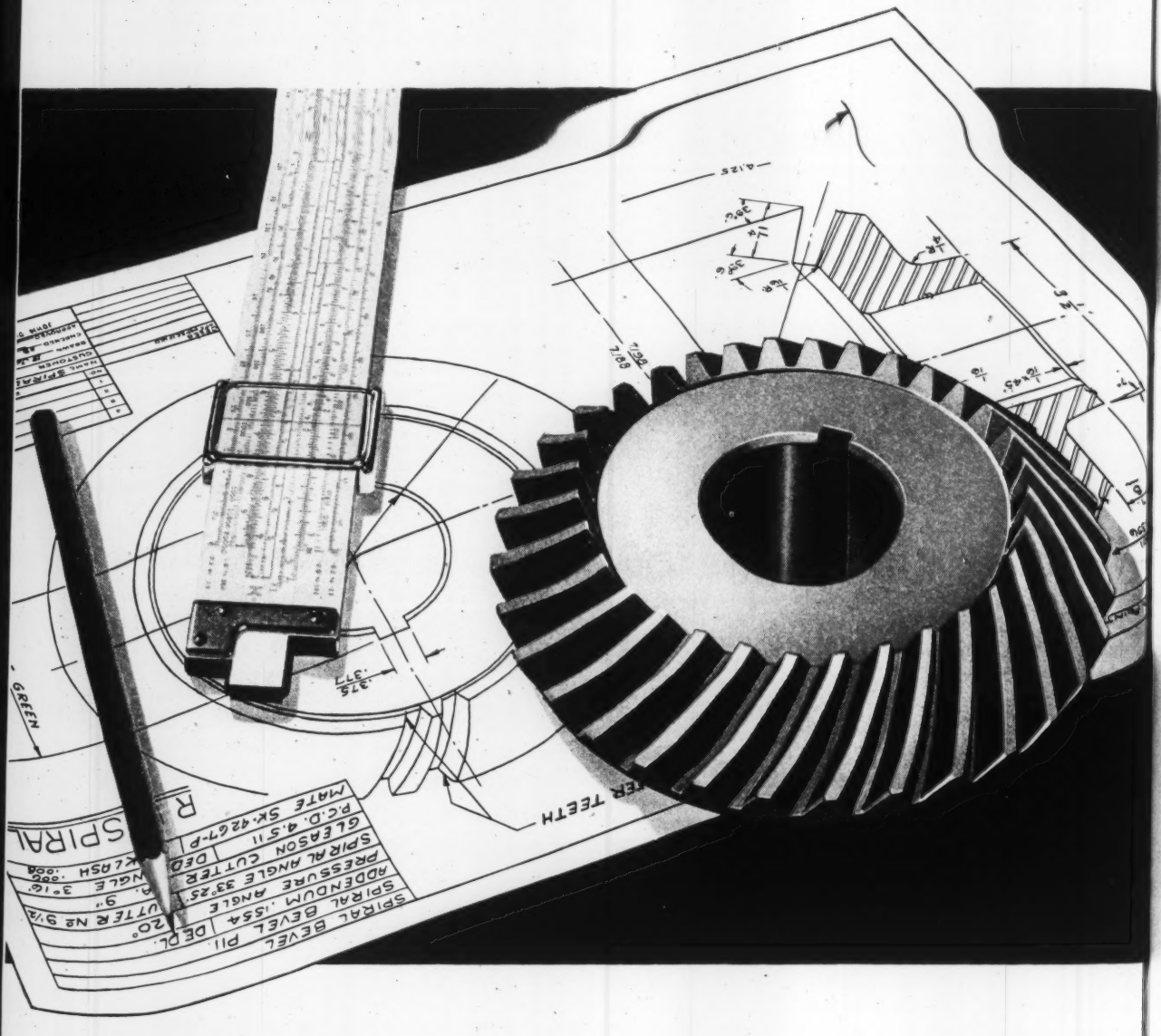
POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
DRAFTING EQUIPMENT & SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

—ITEM 160—

"ENGINEERED QUOTATIONS"

When our engineers study our customers' prints, they look for ways to improve gear performance, ways to simplify gear installations, ways to cut gear costs. When they find a way that they consider better they report it to the customer for his consideration. Very often these "engineered quotations" are accepted. Such careful scrutiny of every engineering and manufacturing step by *gear specialists* is one reason why so many manufacturers use Automotive Gear Works as their "gear department". May we submit an "engineered quotation" on your gear requirements?



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FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS

GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

ESTABLISHED IN 1914

RICHMOND, INDIANA

Reader Information Service

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USE A YELLOW CARD *for More Information . . .*

CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carries an Item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers

EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

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JAN. 12, 1956

Circle item number for information on products advertised or described or copies of literature.

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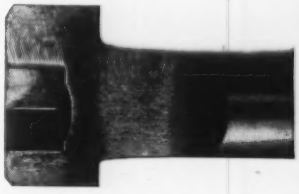
The BUY word for

Socket Cap Screws

is ALLEN

The *easy* way to make sure of greater strength, better fit and uniform quality in socket cap screws is to order "not just Allen-type but genuine ALLEN."

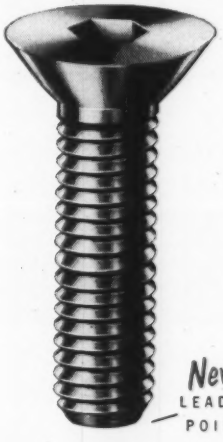
PRESSUR-FORMING



The latest improvement in the cold forging method originated by Allen. The tough Allenoy steel fibers are preserved continuous and uncut.

GRIP HEAD CAP SCREWS

The world's easiest starting, straightest driving, firmest holding cap screws.



FLAT HEAD CAP SCREWS

For firm fastening with flush surfaces. Especially adapted to fastening thin plates and sheets.

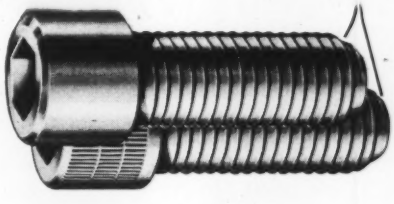
BUTTON HEAD CAP SCREWS

Produces smooth streamlined appearance where countersinking is impractical.

STAINLESS STEEL

New LEADER POINT

Bright, non-corroding high tensile strength type 18-8. 151 popular sizes (NC & NF) with Smooth Heads *available from stock.* Also standard with Grip Heads in many popular sizes.



THE ALLENUT

Provides a ready-made threaded hole for use with cap screws in soft materials and for repair applications. Endless uses for compact design, space saving.

Sold Only Through

Leading

Industrial Distributors

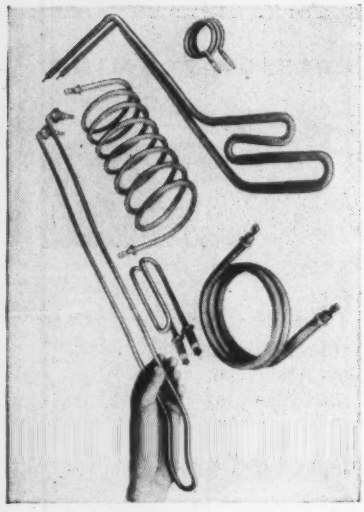
Take advantage of their large stocks and fastener experience. Write direct for General Catalog G55.

ALLEN

MANUFACTURING COMPANY

Hartford 2, Connecticut, U.S.A.

ALLEN HEAD



CHROMALOX
Electric
TUBULAR HEATERS

provide controlled and dependable conduction, convection or radiant heat

These versatile Chromalox Tubular Heaters provide the kind of heat you need, exactly fitted to your specific heating application.

Available in straight lengths or formed to any desired shape. Used for heating dies, molds, platens; as immersion heaters in liquids, soft metal and molten salts; or in ovens, air ducts and other air heating applications.

Let the Chromalox Sales Engineering staff solve your heating problems . . . electrically

Write for your copy of Catalog 50

—for full information on the complete line of Chromalox Electric Heaters and controls.

For ideas on additional applications of electric heat, request Booklet F1550—"101 Ways to Apply Electric Heat."

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7575 Thomas Boulevard, Pittsburgh 8, Pennsylvania

EDWIN L. WIEGAND COMPANY
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☐ a copy of "101 Ways"
☐ a Sales Engineer contact me.

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Company_____

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A-4466A

—ITEM 163—

Engineering News Roundup

(*Continued from Page* 15)

pounds of molten aluminum are used per hour. Bauer added that all the 129 holes are cored and cast to size. The die-cast blocks will undergo intensive testing.

Based on experience with the six-cylinder engine blocks, development of a V-8 aluminum engine block which will weigh between 70 and 75 pounds is underway.

Dynamic obsolescence and color consciousness were subjects discussed in sessions of the Porcelain Enamel Institute annual meeting held recently at White Sulphur Springs, W. Va. "Dynamic obsolescence" is explained as the willing substitution of a new product for one which is still perfectly good, but which does not deliver quite the same satisfaction.

At the same meeting, it was claimed that there are only 500,000 modern kitchens in the country today out of nearly 50 million potential—and that a color revolution is in process. Manufacturers are selling to a changing world and were cautioned not to sell Anna Held colors in a Marilyn Monroe era.

Numerical Sequence Programer Controls Lathe Work Cycle

Electronic Elements Easily Revised, Moved and Repaired

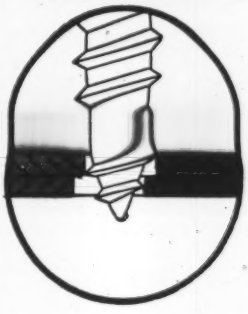
SIDNEY, O. — Automatic electronic sequence programing equipment for Monarch lathes has been developed and introduced recently by the Monarch Machine Tool Co.

The "Numerical Sequence Programer" makes available easily selected, fully automatic work cycles for volume production of precision pieces. Key unit in the numerical sequence programing equipment is the electronic control panel. The panel incorporates push-type selectors which are used to preset the various operations desired from the machine for the particular workpiece to be turned. Once the proper sequence is programed with the selectors, a touch of the start button by the operator sets in motion up to five automatic work cycles using as many

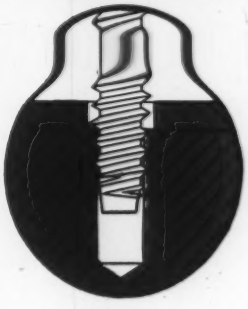
Numerical Sequence Programer recently introduced by the Monarch Machine Tool Co. controls one of the company's 10-inch series EE lathes. Control cabinet at right is easily moved on its own casters. Electronic components it houses are arranged on removable plug-in chassis which simplify maintenance

For Self-tapping Screws that...

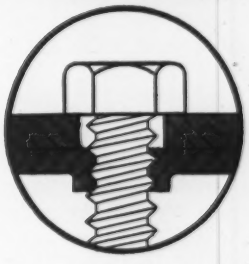
Start Right



Drive Right



Seat Right



Millions in savings made with P-K Screws since they were originated by Parker-Kalon have proved the Self-tapping Screw *method* reduces assembly costs.

But it takes more than the right method to make sure planned savings pay off. It takes P-K quality standards to guard against defective screws that cause assembly trouble, costly damage to parts, and hidden weakness that shows up in customer complaints.

Only Parker-Kalon can offer P-K quality, the indispensable extra, along with the proved advantages of Self-tapping Screws.

Plan your assemblies for lowest cost . . . a P-K Assembly Engineer will help you. Then make sure *planned* savings *keep on paying off* . . . when you purchase, order "P-K". Parker-Kalon Division, General American Transportation Corporation, Clifton, New Jersey.

Stay Tight

PARKER-KALON®

The First SELF-TAPPING SCREWS

originated by P-K . . . and first today . . .
the leading choice for fastening economy

Remember P-K means OK

—ITEM 164—
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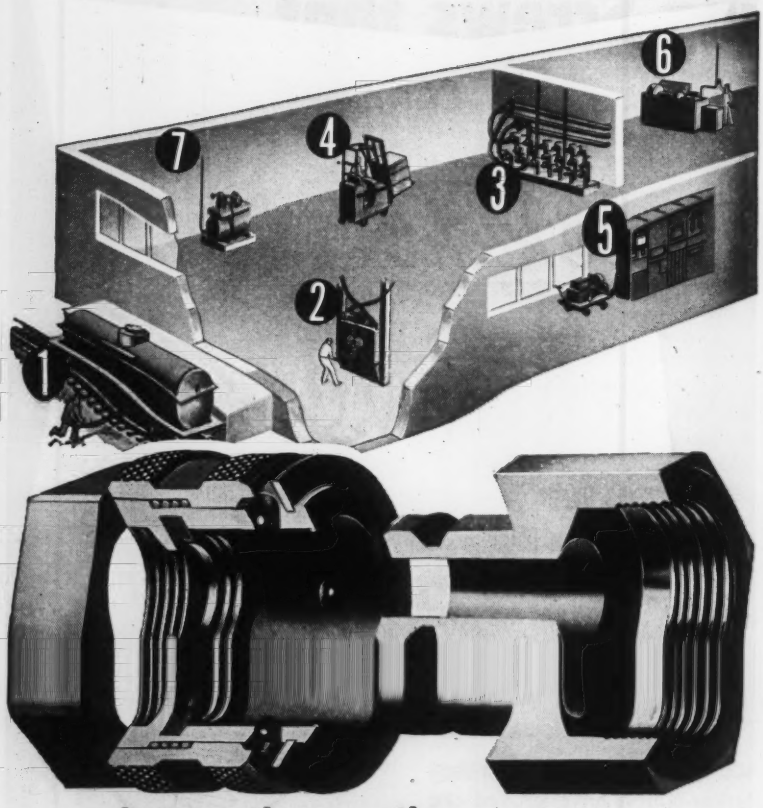

whatever the operation . . .
Titeflex Quick-Seal Couplings for fast, leakproof connections!

Everywhere in industrial operations, you find Titeflex Quick-Seal Couplings "making connections"! And what connections! *Absolutely* leakproof. Couple or uncouple in *one second*. Allow free flow of *any* material. Sizes ¼" to 12".

See drawing for typical uses. Then check your own plant for trouble spots where Quick-Seal Couplings can serve you *profitably*. For details . . . send coupon.

1. Tank Car Unloading
2. Furnace Doors
3. Blending "Switchboards"
4. Lift Trucks—Hydraulic Lines
5. Mobile Testing Equipment
6. Machine Cleaning
7. Air Lines for Tools

Titeflex

TITEFLEX, INC. (Industrial Products Div.)
508 Hendee Street, Springfield, Mass.
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Firm_____
Address_____
City_____ Zone_____ State_____

Titeflex Quick-Seal Couplings • *Leakproof at all operating pressures, in every application*

—ITEM 165—
For More Information Circle Item Number on Yellow Card—page 19

News Roundup

as five varied spindle speeds and five different feed rates.

Functioning in conjunction with the electronic control panel is an analog-to-digital converter sensitive to the machine's carriage motion. The converter sends electrical impulses to the control circuits at precise points in the automatic work cycles, thus actuating the various operations called for by the panel selectors.

Changing the programer of the lathe from one sequence of automatic operations to another, completely different, sequence is said to be fast and simple. A revision must be made in the setting of the control-panel selectors. The selector settings can be changed manually by the foreman or operator; a master board can be used which will simultaneously depress the required selectors when placed in contact with the control panel; or punched cards computed by the plant methods department can be slipped over the selectors to show, through the punched holes, the exact pattern to be set for a given operation.

New Hampshire Ball Bearings Inc. announced plans for the construction of a new 40,000 sq ft plant for bearing manufacture.

Meetings
AND EXPOSITIONS

Jan. 20—

Malleable Founders' Society. Semi-Annual Meeting to be held at Hotel Cleveland, Cleveland, O. Additional information may be obtained from society headquarters, 1800 Union Commerce Bldg., Cleveland 14, O.

Jan. 23-25—

American Society of Heating and Air Conditioning Engineers, Inc. Annual Meeting to be held at Cincinnati, O. Additional information may be obtained from society headquarters, 62 Worth St., New York, N. Y.

Jan. 23-26—

Plant Maintenance & Engineering Show to be held at Convention Hall, Philadelphia, Pa. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 23-27—

Institute of the Aeronautical Sciences. Twenty-fourth Annual Meeting to be held at Hotel Sheraton-Astor, New York, N. Y. Additional information may be obtained from society headquarters, 2 East 64th St., New York 21, N. Y.

Jan. 24-27—

American Management Association. General Management Conference to be held at Hotel Fairmont, San Francisco, Calif. Additional information may be obtained from society headquarters, 330 West 42nd St., New York 36, N. Y.

Jan. 30-Feb. 3—

American Institute of Electrical Engineers. Winter General Meeting to be held at Hotel Statler, New York, N. Y. Additional information may be obtained from society headquarters, 33 West 39th St., New York, N. Y.

Feb. 1-2—

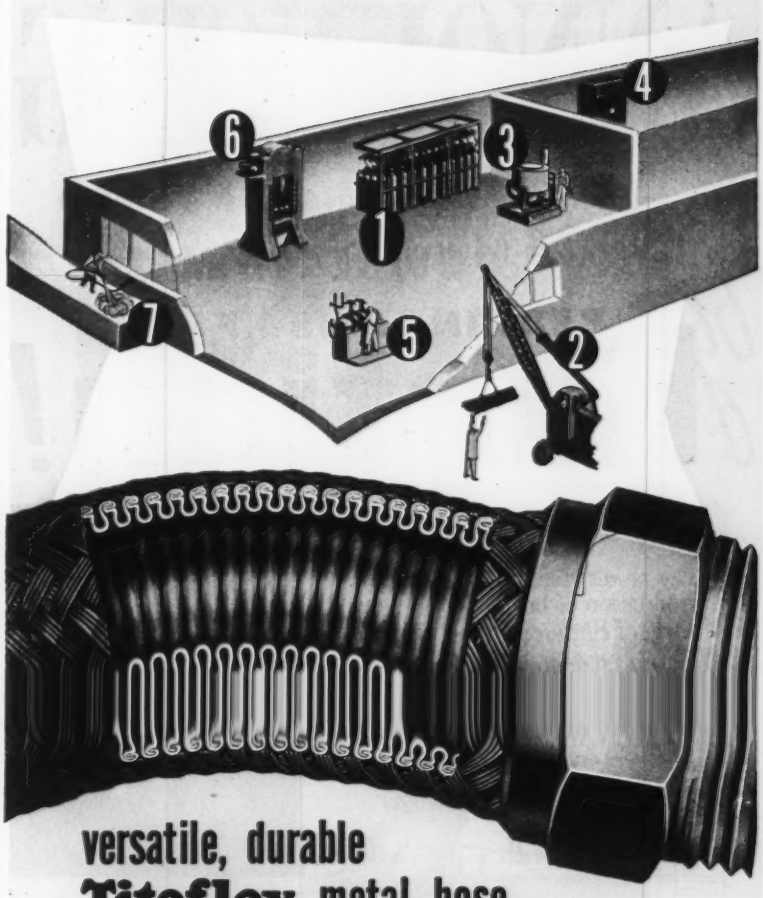
Midwest Welding Conference to be held at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. Sponsored jointly by the Foundation and the Chicago section of the American Welding Society. Harry Schwartzbart, 35 West 33rd St., Chicago 16, Ill., is conference chairman.

Feb. 7-9—

The Society of the Plastics Industry, Inc. Eleventh Annual SPI Reinforced Plastics Division Conference to be held at Hotel Chalfonte-Haddon Hall, Atlantic City, N. J. Additional information may be obtained from society headquarters, 67 West 44th St., New York 36, N. Y.

Feb. 8-10—

Western Computer Conference to be held at the Fairmont Hotel, San Francisco, Calif. Sponsored by the American Institute of Elec-



versatile, durable
Titeflex metal hose . . .
for every type of processing operation

Can take grueling punishment from corrosive fluids, high temperatures, excessive vibration and pressures . . . or from any combination of these industrial *spoilers*. All-metal construction. Wide range of sizes. Braided or unbraided. Choice of alloys and fittings to meet *every* need.

Titeflex Metal Hose finds many important jobs *everywhere*. Investigate your processing operations now and see where Titeflex Flexible Metal Hose can work for you. Send in coupon for important additional information *today*.

1. Fire Extinguisher
2. Air Control Lines
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508 Hendee Street, Springfield, Mass.
Send me your free Titeflex Flexible Hose Catalog without obligating me.

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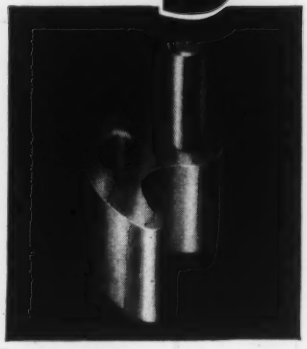
TITEFLEX FLEXIBLE METAL HOSE licks corrosion temperature vibration pressure *in all industrial operations*

—ITEM 166—

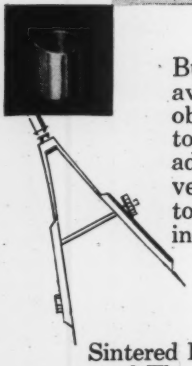
ANNOUNCING

... SINTERED POWDERED METAL BEARINGS and PARTS by Bunting!®

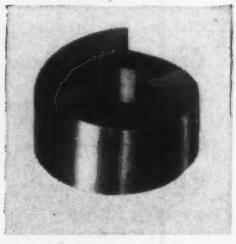


The newest facilities for the production of bearings and parts made of Sintered Powdered Metal are now offered to designer, engineer and machinery manufacturer by The Bunting Brass and Bronze Company.

Bunting resources, reputation and responsibility together with a complete new plant and modern equipment provide Sintered Powdered Metal products at a high point of quality and precision.



Bunting Engineering is available without cost or obligation to all who wish to use or explore the cost advantages that this versatile product brings to the mechanical industries.



Sintered Plain and Flange Bearings, Solid and Tubular Bars and Thrust Bearings are available from stock in a wide range of sizes. Quotations for special bearings or special parts will be sent promptly on receipt of prints.

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

—ITEM 167—

For More Information Circle Item Number on Yellow Card—page 19

News Roundup

trical Engineers, Institute of Radio Engineers and Association for Computing Machinery. Additional information may be obtained from AIEE headquarters, 33 West 39th St., New York, N. Y.

Feb. 20-23—

American Institute of Mining and Metallurgical Engineers. Annual Meeting to be held at New York, N. Y. Additional information may be obtained from society headquarters, 29 West 39th St., New York 18, N. Y.

Feb. 26-29—

American Institute of Chemical Engineers. Meeting to be held at Hotel Statler, Los Angeles, Calif. Additional information may be obtained from society headquarters, 25 West 45th St., New York 36, N. Y.

Feb. 27-29—

American Management Association. Second Annual Electronics Conference & Exhibit to be held at Hotel Commodore, New York, N. Y. Additional information may be obtained from society headquarters, 330 West 42nd St., New York 36, N. Y.

Feb. 27-March 2—

American Society for Testing Materials. National Meeting to be held at Hotel Statler, Buffalo, N. Y. Additional information may be obtained from society headquarters, 1916 Race St., Philadelphia 3, Pa.

March 6-8—

Society of Automotive Engineers. National Passenger Car, Body and Materials Meeting to be held at Hotel Statler, Detroit, Mich. Additional information may be obtained from society headquarters, 29 West 39th St., New York 18, N. Y.

March 8-9—

The Society of the Plastics Industry, Canada, Inc. Fourteenth Annual SPI Canadian Conference to be held at the Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada. Additional information may be obtained from society headquarters, 67 West 44th St., New York 36, N. Y.

March 12-16—

National Association of Corrosion Engineers. Twelfth Annual Corrosion Conference to be held at Hotel Statler, New York, N. Y. A. B. Campbell, 1061 M & M Bldg., Houston 2, Texas, is executive secretary.

March 12-16—

National Electrical Manufacturers Association. Winter Meeting to be held at the Edgewater Beach Hotel, Chicago, Ill. Additional information may be obtained from society headquarters, 155 East 44th St., New York 17, N. Y.

March 14-15—

American Society of Mechanical Engineers. Engineering Management Conference to be held at Hotel Statler, St. Louis, Mo. Additional information may be obtained from society headquarters, 29 West 39th St., New York, N. Y.

March 14-16—

American Society of Mechanical Engineers. Aviation Division Conference to be held at Hotel Statler, Los Angeles, Calif. Additional information may be obtained from society headquarters, 29 West 39th St., New York, N. Y.

March 18-21—

American Society of Mechanical Engineers. Spring Meeting to be held at the Multnomah Hotel, Portland, Ore. Additional information may be obtained from society headquarters, 29 West 39th St., New York, N. Y.

May 14-17—

Design Engineering Show to be held at Convention Hall, Philadelphia, Pa. Additional information may be obtained from Clapp & Poliak, 341 Madison Ave., New York 17, N. Y.

May 24-25—

Third Conference on Mechanisms to be held at Purdue University, West Lafayette, Ind. Sponsored by the Purdue School of Mechanical Engineering and MACHINE DESIGN. Additional information may be obtained from the Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

Cramer
RUNNING TIME METERS
Type 631E
Type 640B
Portable reset type
Type 650
Precision totalizer
Type 630E
Flush panel mounted
Type 640E
Fully enclosed, with reset wheel
widest time ranges.. variety of models
The Cramer line of running time meters and time totalizers offers a complete selection for measuring and accumulating time intervals, from the hundredth part of a second to hours.
A variety of types—reset or non-reset . . . meter mounted or portable . . . drum or dial counters—are available to meet your exact requirements, and all are driven by the precision-built, high torque Cramer synchronous motor.
Whether used for research, preventive maintenance, or recording operating characteristics of a machine or system, you'll find a Cramer time totalizer ideal for the job.
Write for Bulletin PB-610.
Cramer TIMING DEVICES
SPECIALISTS IN TIME CONTROL
The R. W. CRAMER CO., Inc.
BOX 6, CENTERBROOK, CONNECTICUT
ICR56B
—ITEM 168—

For Ideas Unlimited...

consider a ball

Like everyone else who lives by "ideas," you, too, may now and then find yourself face-to-face with a blank drawing pad, wondering where your *next* idea is coming from . . .

Next time you are, think of a ball . . .

A Universal Ball.

You're likely to find *so many new ideas* hidden inside *just one* microscopic-size Universal Ball (to say nothing of the bigger ones) you'll have an idea backlog that will *never* run dry.

Fifteen years ago, for instance, who ever thought we'd be using a *ball* as a writing instrument? Well any day, now (perhaps *every* day), someone may design a product that's just as revolutionary . . . A product just as profitable . . . A product built around a Universal Ball—a ball that is *better than* 10-millionths of an inch accurate!

It *could* be *you*. And we'll be glad to help at the drop of a postcard.

Universal Ball co.

WILLOW GROVE
MONTGOMERY CO., PA.

—ITEM 169—

MEN OF MACHINES

Laurence D. Shergalis has been promoted to associate editor of MACHINE DESIGN. Mr. Shergalis joined our staff in February, 1954, as an assistant editor. He was previously an electronic project engineer at Hickok Electrical Instrument Co. and also had been associated with Brush Development Co. and the Cleveland Electric Illuminating Co. Mr. Shergalis received his B.S. in electrical engineering from Case Institute of Technology and also holds a law degree from Cleveland-Marshall Law School. He is a member of the American Institute of Electrical Engineers, the Cleveland Engineering Society and is a registered professional engineer in Ohio.

Laurence D. Shergalis

Henry W. Brock has been named assistant director of research and development by Standard Products Co., Cleveland. Mr. Brock was formerly manager of engineering services for Jack & Heintz Inc. and also had been associated with Cleveland Tractor Corp., Oliver Corp. and the Winton Engine and White Motor companies.

Wagner Electric Corp., St. Louis, has announced the appointment of **Paul C. Ford** as chief engineer of its Electrical Div. He succeeds **C. P. Potter,** who is retiring. Mr. Ford joined Wagner in 1937 as a student engineer. He worked in the distribution and power transformer engineering sections, was named supervisor of the unit substation and dry type transformer engineering section in 1950, and since 1953 has been assistant manager of the Transformer Engineering Div.

Earl M. Douglas has been named vice president of Dana Corp., Toledo, O., with responsibility for technical activities relating to product engineering. Mr. Douglas, who has an extensive background in the automobile industry, first worked in the shop of the Haynes-Apperson Co. and subsequently was affiliated with Marmon and Stutz motor car companies. From

Earl M. Douglas

Four Sizes
10-16-26-35
lb-in torque100/psi

A New Series of DUAL-VANE Fluid Motors To Better Perform Functions Calling for Rotary Power

to better perform functions calling for rotary power. DUDCO Fluid Motors operate at higher continuous pressures . . . provide greater continuous horsepower output without increasing motor size. DUDCO Fluid Motors start, stop and reverse instantly, operate at an infinite variety of speeds, can even be stalled without damage.

DUDCO MF-100 Series Motors are built for continuous 2000 psi operation. They feature extremely high starting torques and provide constant torque throughout their entire speed range . . . start to 2400 rpm. Four sizes deliver up to 23.5 horsepower.

Member NFPA

Write for Bulletin No. DM-321

THE NEW YORK AIR BRAKE COMPANY
1106-1 EAST 222nd STREET • CLEVELAND 17 • OHIO
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

MOBILE EQUIPMENT

BUILDERS TAKE TO HYDROSTATIC DRIVES

MODERN HYDRAULIC PUMPS AND MOTORS MAKE MACHINES MORE PRODUCTIVE

Nearly all types of mobile equipment require power at locations remote from the central power source. The transmission of this power has long been a problem to mobile equipment builders and operators. Complicated mechanical-type transmissions have proven costly and troublesome. Breakdowns were expensive in repair costs and lost production time.

Recently builders of mobile equipment have found a simple and dependable solution to this problem. They have been able to add functions to equipment and transmit power by the use of hydrostatic drives.

A hydrostatic drive generally consists of a constant displacement hydraulic pump, a constant displacement fluid motor, a directional control valve and connecting pipes or hoses. The hydrostatic drive effects power transfer by means of pressure changes rather than by velocity changes as do torque converters or fluid couplings.

Many advantages are found in the use of hydrostatic drives. Power is easily transmitted to remote and inaccessible places. Infinite speed ratios and accurate output speeds are possible. The operator can control his machine through run, idle or reverse operation with just a simple control valve. The system provides automatic overload and shock protection.

Successful applications of hydrostatic drives have been made on farm machinery to operate cutter bars, drive combines and run conveyors. On construction equipment they drive ditchers, rotate grader blades and operate cranes and winches. In the materials handling field these drives rotate clamps and propel small platform trucks. The adaption of hydrostatic drives to all types of machines seems unlimited.

DUDCO MF-100 Series Fluid Motors and PFM-100 Series Hydraulic Pumps have been developed by The New York Air Brake Company to provide hydrostatic drives for equipment which must give continuous, dependable service.

ENGINEERS

Exceptional opportunities for men of imagination to express new ideas in the design and development of Hydraulic Components. Company expansion and progress in this growing industry promise rewarding futures for engineers who qualify. Write, giving experience and full details.

The New York Air Brake Company
1106-1 East 222nd Street
Cleveland 17, Ohio

Gentlemen:

I would like further details on the new DUDCO MF-100 Series Fluid Motors ☐
Also details on DUDCO PFM-100 Pumps ☐

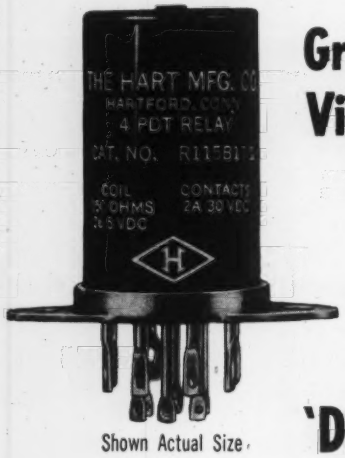
Name_____ Title_____

Company_____

Address_____

City_____ Zone___ State_____

—ITEM 170—



Shown Actual Size

Greater Sensitivity, Vibration Resistance *Engineered in* 'Diamond H' Relays

Continuing development of "Diamond H" miniature, hermetically sealed, aircraft type relays is constantly widening their performance range. Now, for example, in a 4 PDT relay: sensitivity to 85 mw with vibration resistance of 500 cycles at 10 "G" and 30 "G" shock resistance; vibration resistance of 55 to 2,000 cycles at 20 "G" with 50 "G" shock resistance and maximum sensitivity of 1½ watts.

Excellent contact reliability makes "Diamond H" relays preferred choice for critical jobs in vital applications ranging from guided missiles to high speed camera equipment.

TYPICAL PERFORMANCE CHARACTERISTICS

Vibration Resistance:	10-55 cycles at 1/16" double amplitude 55-500 cycles at 15 "G" 55-1,000 cycles at 15 "G" 55-2,000 cycles at 20 "G"
Temperature Range:	—55° to + 85°C. —65° to + 125°C. —65° to + 200°C.
Coils:	Resistances—1 ohm to 50,000 ohms Arrangements—single coil; two independent coils, either or both of which will operate unit
Insulation Resistance:	1,000 megohms at room temperature 100 megohms at 200°C.
Dielectric Strength:	450 to 1,250 V., RMS
Operating Time:	24 V. models 10 ms. or less; dropout less than 3ms.
Contacts:	30V., D.C.; 115V., A.C.; 2, 5, 7½ and 10A., resistive; 2 and 5A. inductive. Minimum 100,000 cycles life. Low interelectrode capacitance — less than 5 mmf. contacts to case; less than 2½ mmf. between contacts. Special Ratings: to 350 V., D.C., 400 MA., or other combinations including very low voltages and amperages or amperages to 20.
Operational Shock Resistance:	30, 40 and 50 "G" plus
Mechanical Shock Resistance:	up to 1,000 "G"
Mounting:	9 standard arrangements to meet all needs — plus ceramic plug-in socket.
Size:	1.6 cu. in.
Weight:	4 oz. or less

Call on "Diamond H" engineers to work with you in developing a variation to meet your specific requirements.

THE HART MANUFACTURING COMPANY
118 Bartholomew Avenue, Hartford, Connecticut

Men of Machines

1928 to his present appointment he was associated with Studebaker.

The Harrison Div. of Worthington Corp., Harrison, N. J., has appointed **William C. Osborne** manager of engineering and **Everett C. Schmachtenberg** assistant to the manager of engineering. Mr. Osborne joined the firm in 1941 as an engineering student. He was named product engineer in 1950, was promoted to manager of the Research and Development Div. in 1952 and, most recently, served as assistant to the manager of engineering.

Mr. Schmachtenberg joined Worthington in 1937 and has served as test engineer, design and application engineer for pumps and compressors, assistant chief engineer and, until his new appointment, as chief engineer of the compressor engineering department.

Hanna Engineering Works, Chicago, has appointed **John T. Ellis Jr.** to the position of chief engineer. Mr. Ellis was on the engineering staff of the Underwriters Laboratories before joining Hanna. He is a member of the American Society of Mechanical Engineers, American Institute of Electrical Engineers and the Instrument Society of America. **John Hanna,** president of the company, has held the title of chief engineer since 1921.

John T. Ellis Jr.

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The board of directors of Cutler-Hammer Inc., Milwaukee, has elected **Philip Ryan** president and chief executive officer. He has been executive vice president and vice president in charge of manufacturing and development engineering since 1951.

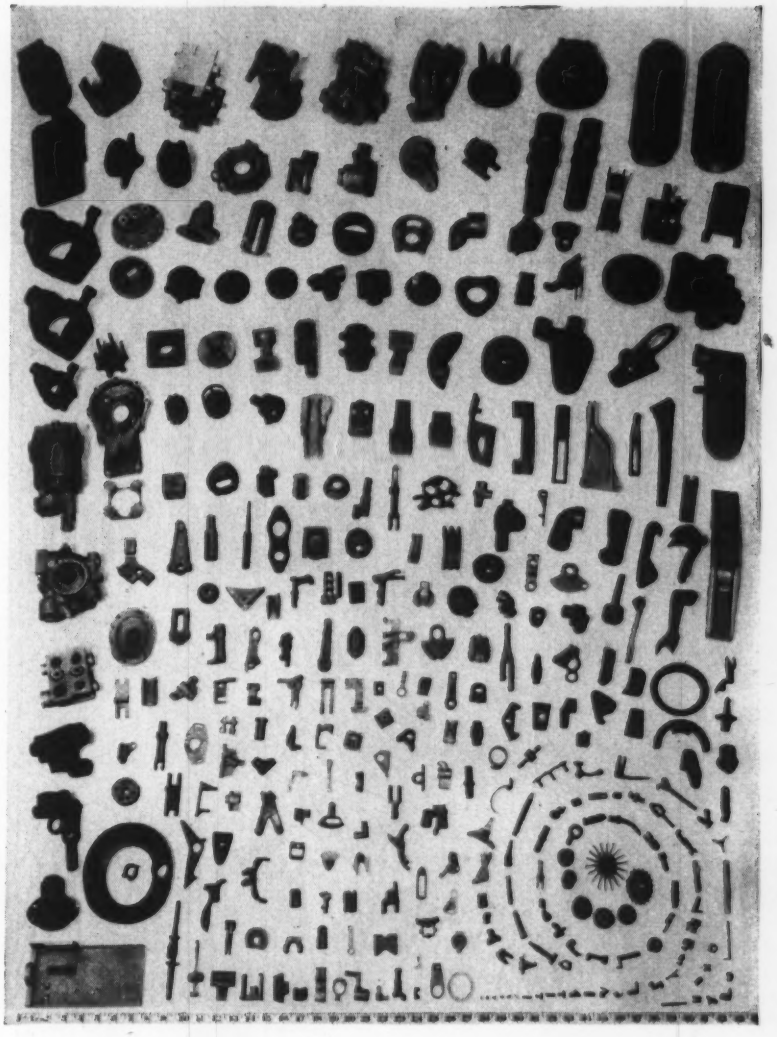
Gilbert C. Gettelman has been promoted to chief development engineer by Geuder, Paeschke & Frey Co., Milwaukee. He joined the company in 1952.

Weston Hydraulics Ltd., North Hollywood, Calif., a subsidiary of Borg-Warner Corp., has appointed **Harvey F. Gerwig** vice president in charge of engineering. He was formerly chief design engineer.

Oliver Mueller has been appointed chief engineer of the Aircraft Controls Div. of Gorn Electric Co., Stamford, Conn. He previously served as chief engineer of Fischer & Porter Co. and as chief tool engineer of the Ordnance Div. of Bell Aircraft Co.

John C. Terry Jr. has joined Machine Products Corp., Detroit, as chief engineer with responsibility for developing inspection techniques for use with the Rotab universal checking table. He was previously gage engineering supervisor for Allison Engine Div. of General Motors Corp. Mr. Terry

John C. Terry Jr.



Investment castings

¼ ounce to 30 pounds... up to 12 inches in length
... 160 ferrous and nonferrous alloys

Precision Metalsmiths makes them all—a million pieces for your production or a few at a time, as you develop a product. Pictured above are some of the investment castings we're making regularly.

Cast to close tolerances and accurate in details, such parts require surprisingly little finishing. Expensive pre-assembly machining is avoided, since complicated parts are produced as single units. We do the assembling with expendable patterns.

Send for the free book, "Pour Yourself an Assembly", describing this time-saving method. Precision Metalsmiths, Inc., 1083 East 200th Street, Cleveland 17, Ohio.

pour yourself an assembly with
PRECISION METALSMITHS, Inc.
Investment Castings

—ITEM 172—
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Positive Overload Protection

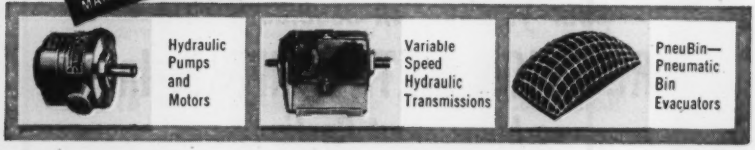
No self-respecting beaver would ever build his dam without sufficient spillways to carry-off superfluous water. This *positive overload protection* is instinctive with the beaver . . . and the new GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION. This transmission protects against overload damage to the drive motor, transmission and driven machine. Get the facts on the low maintenance, high efficiency GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION today . . . WRITE:

GEROTOR

MAY CORPORATION

MANUFACTURERS OF—

1537 MARYLAND AVENUE, BALTIMORE 3, MARYLAND



Men of Machines

also has been employed by the U. S. Air Force, Stewart-Warner Corp., the Aircraft Div. of Armstrong Cork Co. and Consolidated Vultee Aircraft Corp.

The Distribution Assemblies Dept. of General Electric Co., Plainville, Conn., has announced the appointment of **S. S. Price** as manager of panelboard and motor control design engineering and **A. H. Adams** as manager of switchboard and distribution center design engineering. Mr. Price has been associated with General Electric since 1953, and Mr. Adams, since 1945.

Appointment of **Donald C. Duncan** as general manager has been announced by Berkeley Div. of Beckman Instruments Inc., Richmond, Calif.

Accessory Products Corp., Whittier, Calif., has named **Leonard Griffith** head of its new high-pressure pneumatic group. He was previously division engineer in charge of hydraulics and pneumatics at General Controls Co.

With responsibility for the engineering, development and research of all the company's product lines, **Nikolai Belaef** has been appointed chief engineer by Klipfel Valves Inc., a division of Hamilton-Thomas Corp., Hamilton, O.

J. Kneeland Nunan has been named to the new position of vice president and general manager of Clevite Research Center, Cleveland.

Union Switch & Signal Div. of Westinghouse Air Brake Co., Pittsburgh, has announced that vice president **George W. Baughman**, formerly in charge of the Railway Signal Engineering Dept., has been appointed to the staff of the vice president and general manager. The newly established position of director of research and engineering has been filled by **F. E. Lowance**, who was formerly on the staff at Air Brake executive headquarters. Dr. Lowance will also be acting manager of the railway Signal Engineering Dept.,

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with **H. L. Ludwig** as assistant manager. The present research department and the present development group in that department will be merged to form a research and development department, with **E. F. Brinker** as manager and **D. P. Fitzsimmons** as assistant manager.

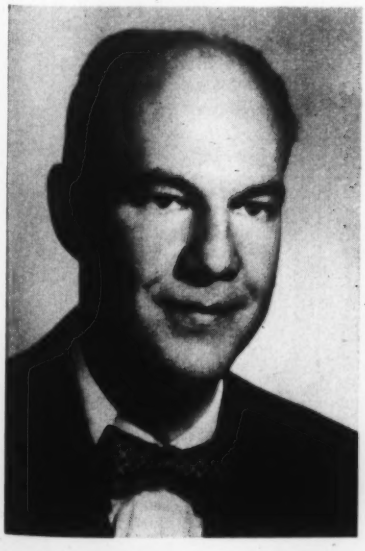
Bjorksten Research Laboratories Inc., Madison, Wis., has announced that **Stuart O. Fiedler** has resumed the position of technical director. He served as vice president and technical director from 1945 to 1947.

Thomas A. Jermyn Jr. has been promoted to chief engineer and assistant superintendent of Kerr-Lakeside Industries Inc., Euclid, O.

Brooks Rotameter Co., Lansdale, Pa., has announced the appointment of **Seymour Blechman** as executive vice president, with responsibility for co-ordination and guidance of product improvement and expansion.

Election of **W. F. Shurts** as vice president of engineering has been announced by Twin Disc Clutch Co., Racine, Wis. Mr. Shurts joined the company in 1940 and in 1942 was named chief engineer of the Hydraulic Div. at Rockford, Ill. In 1951 he was appointed director of engineering.

W. F. Shurts



Special Designs for Special Hydraulic Pump Applications

GEROTOR is noted for its precision-built line of standard design pump models, but unheralded, GEROTOR engineers are solving problems at the request of customers who have special design needs.

The precision manufacturing know-how of the GEROTOR organization is available when you have a special design problem. Whether this involves speed, capacity, limited space, mounting, weight or adaption to some peculiar operating condition, a specially designed GEROTOR HYDRAULIC PUMP may solve your problem.

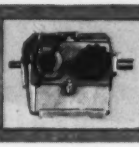
Due to modern facilities, GEROTOR can produce special design pumps in *quantities* on an economical basis. Whatever your hydraulic pump design problem . . . bring it to GEROTOR.

FREE literature available . . . write:

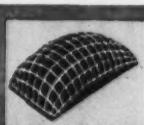
GEROTOR
MAY CORPORATION
1537 MARYLAND AVENUE, BALTIMORE 3, MARYLAND

MANUFACTURERS OF—

Hydraulic Pumps and Motors



Variable Speed Hydraulic Transmissions



PneuBin—Pneumatic Bin Evacuators

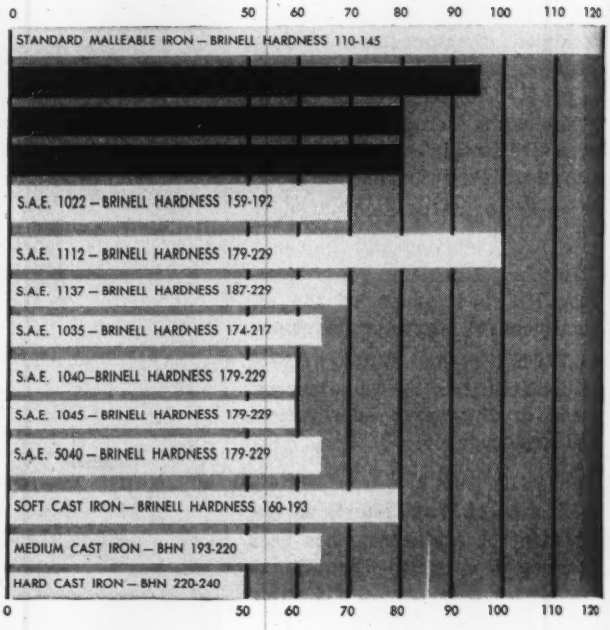
—ITEM 174—

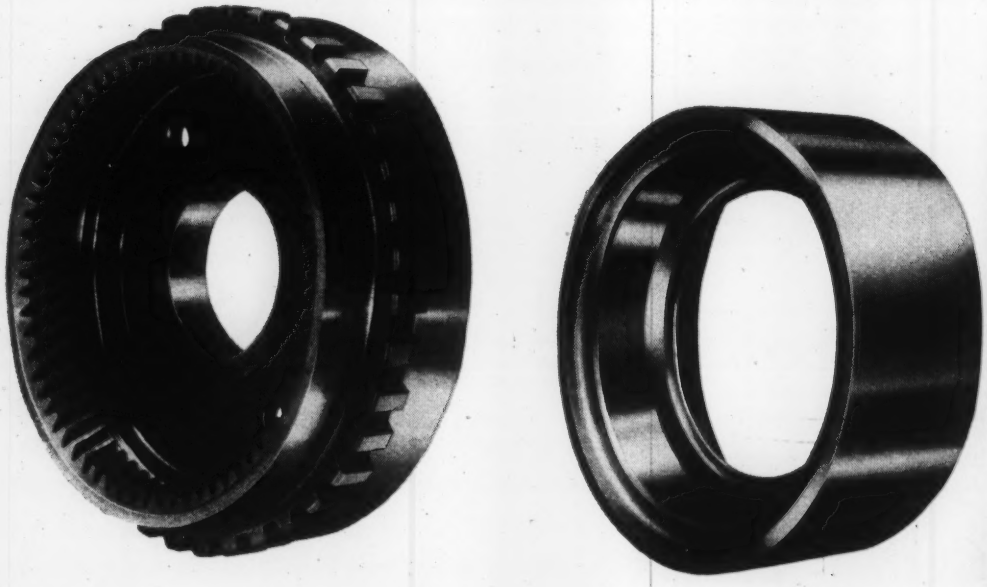
ARMASTEEL®

ArmaSteel's machinability makes it outstanding in the ferrous field. In general, its rating is from 10% to 30% better than bar stock or forgings of the same Brinell hardness. One of the reasons for this rating is the structure, which consists of a matrix of sorbitic-pearlite and spheroidized cementite in which small nodules of carbon are imbedded. Because of this the chips break off more readily in machining operations whether it be turning, drilling, milling or broaching.

The machinability rating of a metal is not absolute—its rating can be stated only in relation to that of another metal. To establish the accompanying machinability rating table Bessemer screw stock S.A.E. 1112 is used as the base. In establishing these ratings, the cutting speed of the S.A.E. 1112 is the rate generally used in turning this metal on automatic screw machines. The rate of feed, however, is altered to that necessary to attain normal tool life and good surface finish when using a coolant. When the other metals are tested, the feeds and speeds are varied from these basic rates to whatever rate is necessary to obtain comparable tool life and comparable surface finish. The ratio of these rates of speeds and feeds

MACHINABILITY RATING (PER CENT)





castings are easier to machine*

of each tested metal determines the percentage of machinability.

ArmaSteel is a versatile pearlitic malleable iron that combines the advantages of both castings and forgings. ArmaSteel parts can be cast by conventional sand method or shell mold process to relatively close dimensions in large quantities at low cost. Because of the excellent, accurately controlled physical properties of ArmaSteel, these parts have the strength and performance characteristics usually associated with plain carbon steel forgings.

ArmaSteel is produced in three ranges: ArmaSteel 84M, ArmaSteel 85M and ArmaSteel 86M with a wide variety of physical properties uniformly maintained through accurate heat treating operations as follows:

ARMASTEEL 84M is recommended where a high degree of strength is necessary. It usually replaces heat-treated steel parts in the 1040-1050 S.A.E. range. It has a hardness range of BHN 241-269 or 3.7-3.9mm. impression with a 3000 Kg. load. Tensile strength is 100,000 p.s.i., yield strength is 80,000 p.s.i., and percent of elongation in 2" is 2.0%.

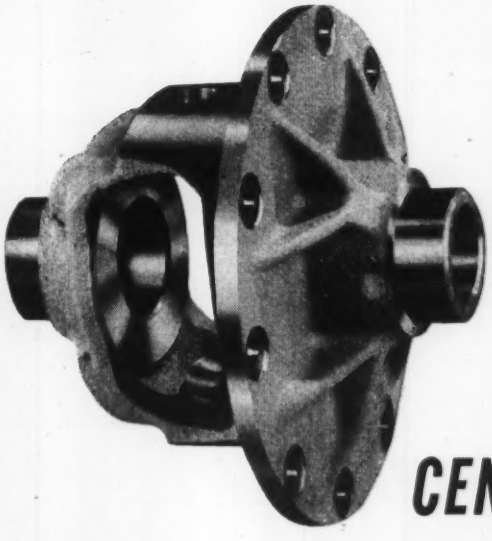
ARMASTEEL 85M is recommended where moderate strength is required and where selective hardening is necessary. This class usually replaces parts in the 1035-1050 S.A.E. range. It has a hardness range of BHN 197-241 or 3.9-4.3 mm. impression with 3000 Kg. load. Tensile strength is 80,000 p.s.i., yield strength is 60,000 p.s.i., and percent of elongation in 2" is 3.0%.

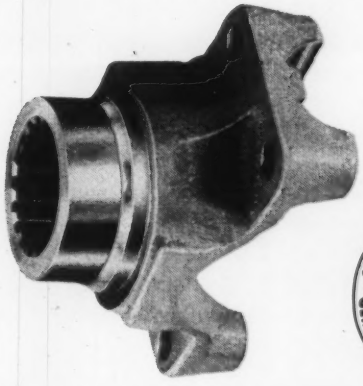
ARMASTEEL 86M is recommended for less highly stressed parts usually replacing steel parts in the 1020-1035 S.A.E. range. It has a hardness range of BHN 163-207 or 4.2-4.7 mm. impression with 3000 Kg. load. Tensile strength is 70,000 p.s.i., yield strength is 48,000 p.s.i., and percent of elongation in 2" is 4.0%.

The FOUR parts illustrated below are typical of the hundreds of different parts and products successfully produced in ArmaSteel for many diversified industries.

Write, today, for new 70 page comprehensive catalog . . . or request personal help from our experienced engineers, without obligation.

*When compared with medium carbon steel forgings.





CENTRAL FOUNDRY DIVISION · GENERAL MOTORS CORPORATION

58

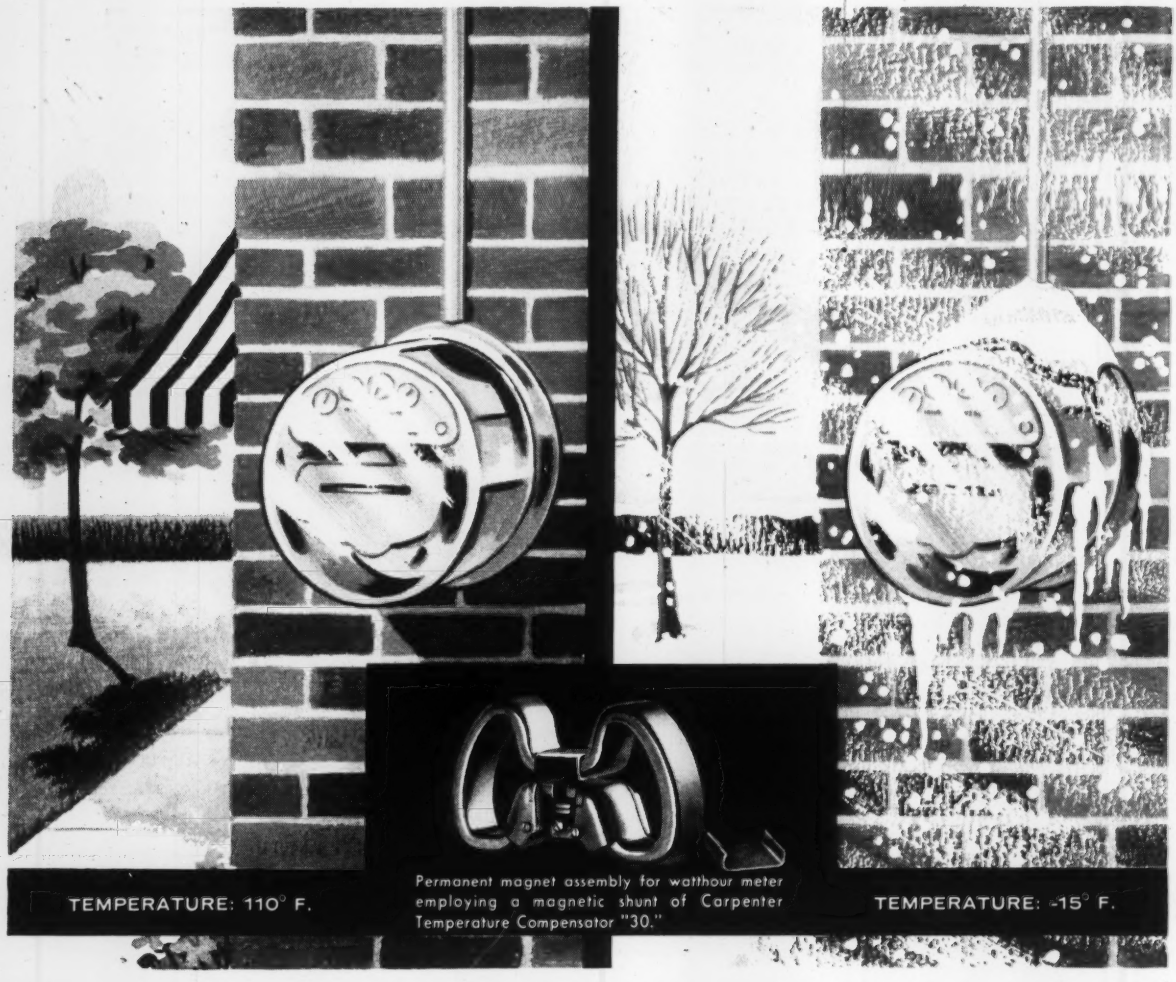
CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 14

—ITEM 175—

For More Information Circle Item Number on Yellow Card—page 19

Carpenter ... pioneering in improved Tool, Alloy and Stainless Steels through continuing research


TEMPERATURE: 110° F.
Permanent magnet assembly for watthour meter employing a magnetic shunt of Carpenter Temperature Compensator "30."
TEMPERATURE: -15° F.

When Precision Equipment Must Behave at Varying Temperatures... Take Advantage of *Carpenter* High Nickel Alloys!

A specially-engineered steel in Carpenter's complete line of high nickel alloys is guarding the accuracy of watthour meter performance in all kinds of weather. Its use covers a wide range of electrical equipment such as watthour meters, voltage regulators, speedometers and aircraft tachometers.

This alloy, Carpenter Temperature Compensator "30", is produced by specialists under strict quality controls. It is another example of how Carpenter's pioneering role in producing *specialty* steels to meet *special* applications works for you in your effort to build better products at a reasonable cost.

And Temperature Compensator "30" is but one of many Carpenter specialties. Other "extremely sensitive" alloys in this line respond to very weak electrical currents . . . permitting you to design smaller, lighter weight units. Still another Carpenter High Nickel Alloy assures precision product performance with practically no size change through temperature ranges up to 400°F.

Take this step for product improvement, now: Write on your company letterhead for detailed information on Carpenter Temperature Compensator, Low Expansion, High Permeability and Glass Sealing Alloys in such forms as strip, wire, bars, tubing and forging billets. *The Carpenter Steel Co., 120 W. Bern St., Reading, Pa.*

Carpenter STEEL

high nickel alloys

Export Department: The Carpenter Steel Company, Port Washington, N. Y.—"CARSTEELCO"

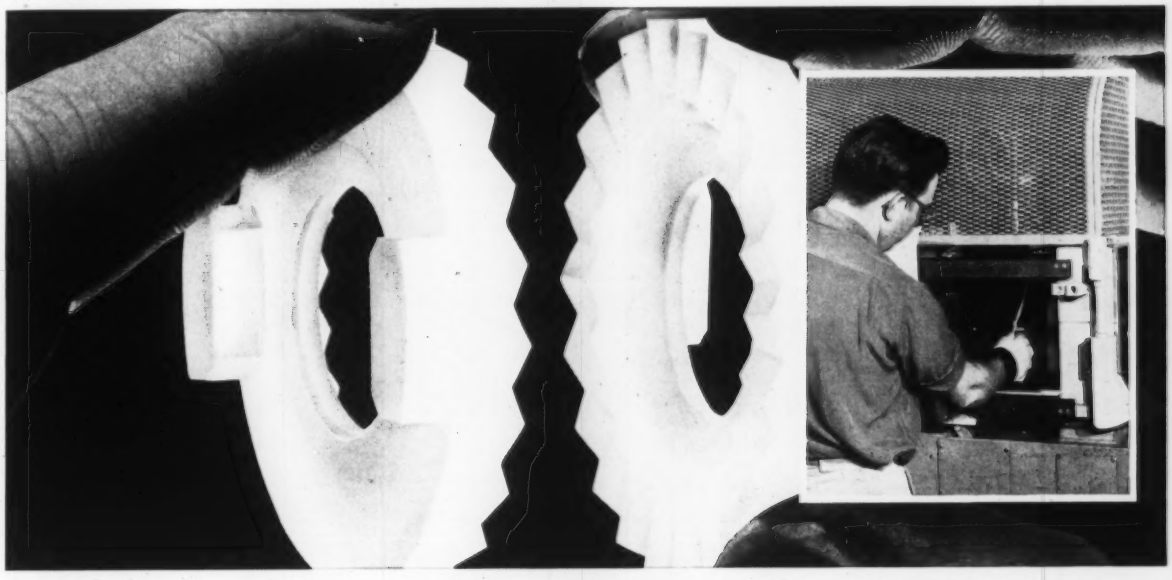
—ITEM 176—
For More Information Circle Item Number on Yellow Card—page 19

DU PONT
REG. U. S. PAT. OFF.

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

PRODUCT ENGINEERING NEWS

Clutch facings of ZYTEL® nylon resin are economically injection molded...last 5 times longer than metal parts replaced



Parts of "Zytel" like these clutch facings can be mass-produced by injection molding (see inset) in multi-cavity dies—a fast, efficient method of fabricating, which generally requires no after-finishing. (Clutch facings molded by Danielson Manufacturing Company, Danielson, Connecticut.)

THIS CLUTCH revolves at 1750 rpm, transmitting 75 ounce-inches of torque. It is engaged and disengaged up to 40 cycles a minute, 24 hours a day. Minnesota Mining & Manufacturing Company, St. Paul, Minnesota, formerly used heat-treated metal facings for this heavy-duty job, but had to replace them an average of 17 times a year. After a change to facings molded of tough, wear-resistant "Zytel" nylon resin, replacements were required only *three times a year!*

The metal clutch components cost $8.75 apiece. Those of "Zytel" are 32¢ each. The savings realized on the first 91 facings of "Zytel" covered the costs of the die required to mold these precision parts. Minnesota Mining & Manufacturing Company estimates an annual saving of $150.00 per clutch installation, to which can be added savings which accrue from only three machine shutdowns a year instead of seventeen.

This kind of efficiency and economy can be yours if you examine the properties of "Zytel". Designers and engineers have found endless uses for this versatile material. Some of the many successful applications of "Zytel" are bearings, gears, cams, rollers and bushings. Learn more about the resilience, heat resistance, and strength of "Zytel". Apply its combination of properties to your product needs. For information on Du Pont "Zytel", mail the coupon on the next page.

OVER

The protective shield of "Lucite" acrylic resin on this Kalart flash attachment was molded by T. F. Butterfield, Inc., Naugatuck, Connecticut.

Crystal-clear safety shield of LUCITE® protects against flashbulb shatter

BECAUSE it is transparent and durable, "Lucite" acrylic resin offers outstanding advantages. Its high impact strength and weather resistance afford long wear and heavy-duty service. "Lucite" gives optimum transparency and can be colored to provide unusual decorative effects.

An interesting application of this engineering material is in the new Kalart flash attachment. "Lucite" is used for a safety shield protecting subjects from possible shatter of flashbulbs. Economically molded, "Lucite" withstands heat without discoloring.

XUM

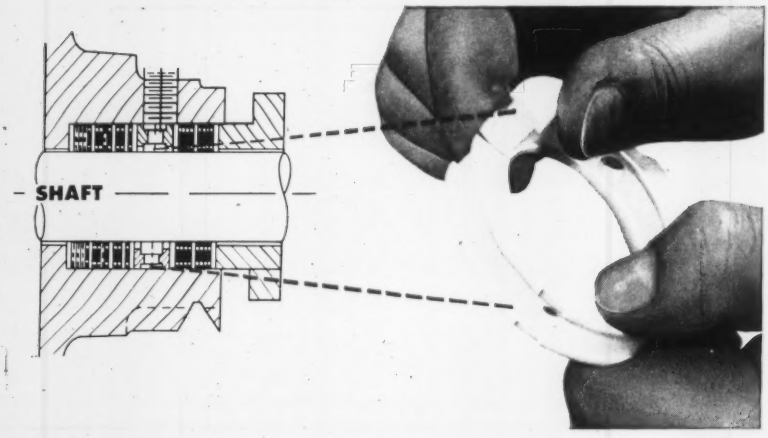
DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living ... through Chemistry

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Du Pont TEFLON® for flexible seal cages which snap in place easily, won't score shaft



Effective sealing without danger to the shaft is possible with seal cages of "Teflon". These flexible cages snap on and off quickly and give long wear under rugged conditions. (Manufactured by Chemical and Power Products, Inc., New York, New York.)

"Teflon" is strong and chemically inert through a wide temperature range

THESE flexible seal cages of Du Pont "Teflon" tetrafluoroethylene resin supply annular space in packing for lubrication with oil or grease, or for cooling. Users of pumps and other process equipment will appreciate how quickly and easily these flexible seal cages of "Teflon" snap on and off a shaft. They're tough—won't bend or collapse under extreme gland pressure. Yet, because "Teflon" is non-adhesive, there's no danger of a scored shaft or sleeve from these seal cages.

"Teflon" is used extensively in chemical, electrical and mechanical applications. Its chemical inertness, high heat resistance ("Teflon" operates in many applications at temperatures as high as 500°F.), low temperature toughness, and low coefficient of friction make this engineering material particularly adaptable to severe service conditions. Possibly "Teflon" can solve an engineering problem for *you*.

Shield of ALATHON® solves insulation problem in new RCA Victor color TV receiver

THE PICTURE TUBE in the new RCA Victor color television receiver operates at 25,000 volts. To provide insulation for this tube, RCA engineers needed a material that could be readily and inexpensively molded into the complex shape of a kinescope shield . . . yet had high dielectric strength. Du Pont "Alathon" polyethylene resin proved to be an ideal material for the shield on all counts. In addition to providing the needed insulation, the shield of "Alathon" gives mechanical protection to the tube when it is shipped or handled.

"Alathon" not only has excellent insulating properties but is strong, lightweight and flexible. It is chemical resistant, as well as odorless, tasteless and non-toxic. Because of these properties, and the ease with which parts can be molded, extruded or fabricated, "Alathon" has helped engineers solve many design and operating problems.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 121, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel"*; ☐ *"Alathon"*; ☐ *"Teflon"*; ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

Investigate DuPont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties, available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin, are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and application of these Du Pont engineering materials.

NEW! Heavy-duty relay in small space

This new CLARK Type "PM" Control Relay introduces a new concept in relay design: *Sectional Pole Construction.*

In this new relay, each pole is contained in its own melamine housing, and any individual pole can be removed or replaced from the front without disturbing the others. A short circuit is confined to a single pole and will not destroy the whole relay. Wiring terminals are on the front, and all maintenance including coil changing, pole or magnet replacement, is also from the front—without removing relay from panel. Contacts are quickly and easily convertible from normally open to normally closed and vice versa—from the front. Range of models provides relays with 2 to 12 poles. Exclusive design allows more contacts per square foot of panel space. In addition to the many advantages of SECTIONAL POLE CONSTRUCTION, you get a *heavy-duty relay in small space.*

For complete information write to

The **CLARK CONTROLLER** *Company*

Engineered Electrical Control

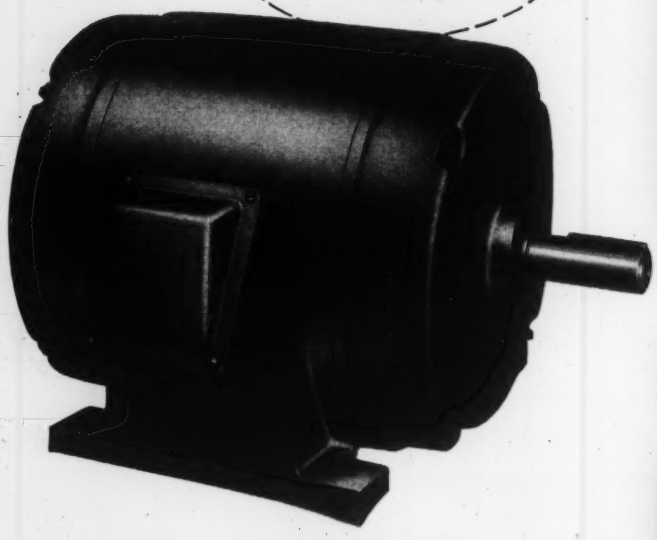
1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA... CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

—ITEM 178—

For More Information Circle Item Number on Yellow Card—page 19

Wagner®
ELECTRIC MOTORS
... the choice of leaders in industry

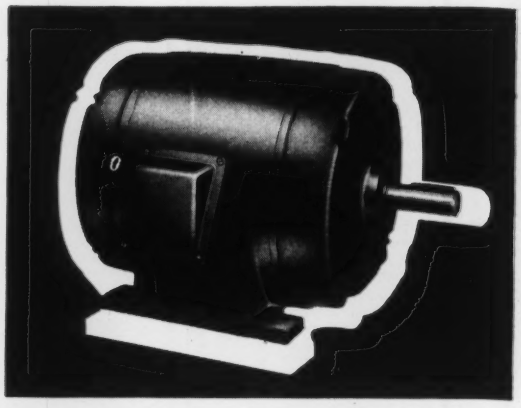


You get better performance with these Wagner DP Motors

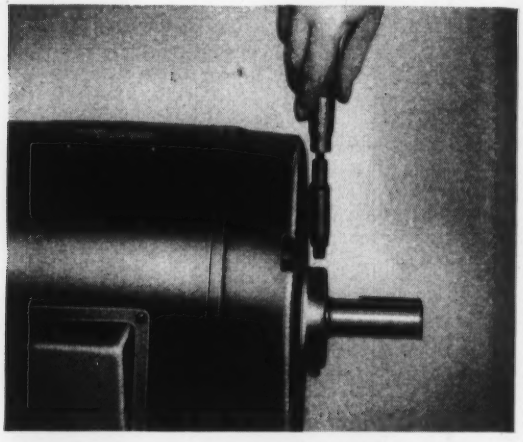
Wagner DP motors are *doubly protected* by (1) rugged, corrosion-resistant cast iron frames, smoothly rounded so that no moisture can collect on them. Motor feet are cast as an integral part of the frame for maximum strength and rigidity. (2) Enclosures on the DP motor are completely drip-proof—virtually splashproof. Air intakes are located at the bottom of the endplates and air outlets are located at the base of the frame—one on each side.

Although engineered to meet the re-rated NEMA specifications which call for more power in smaller frames, the same high quality and long life performance that have made Wagner Motors "the choice of leaders in industry" for many years has of course been retained.

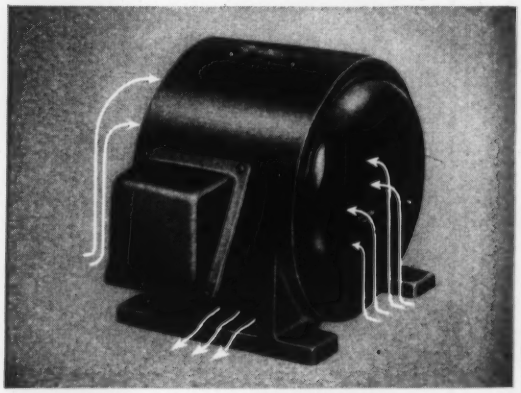
Full information and principal dimensions are given in Bulletin MU-202. Write for your copy today.



MORE POWER IN SMALLER FRAMES The Wagner DP Motor packs more power in a smaller frame and this smaller size means ease of handling and stocking ... less space required for installation.



CAN BE RE-GREASED FOR LONGER LIFE This motor will operate for years without regreasing ... bearings are completely enclosed ... however, provisions have been made for adding lubricant and for the removal of old grease in cases where re-greasing is necessary.



COOL RUNNING Specially designed baffles direct cooling air from the blowers through the motor and provide protection for the stator windings. Blowers are an integral part of rotor ... and move large volumes of air without noise or vibration.

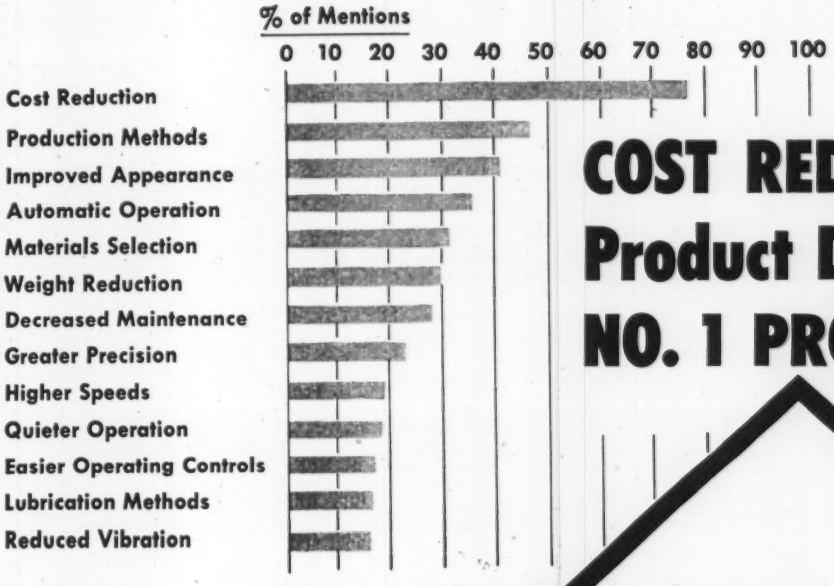
Wagner Electric Corporation
6404 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation EST. 1891

M56-4

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC
—ITEM 179—



Tabulated results of a recent survey showing the problems receiving greatest attention from Product Designers.

COST REDUCTION is Product Designers' NO. 1 PROBLEM...

AND NICE CAN HELP LOWER COSTS

Product Designers will find many cost-saving advantages in the use of NICE precision, semi-precision and unground ball bearings. Experienced NICE Engineers can not only help in the selection of the proper standard bearings, but can design "exactly right" special bearings to meet particular application requirements.

WRITE FOR CATALOG No. 150

NICE

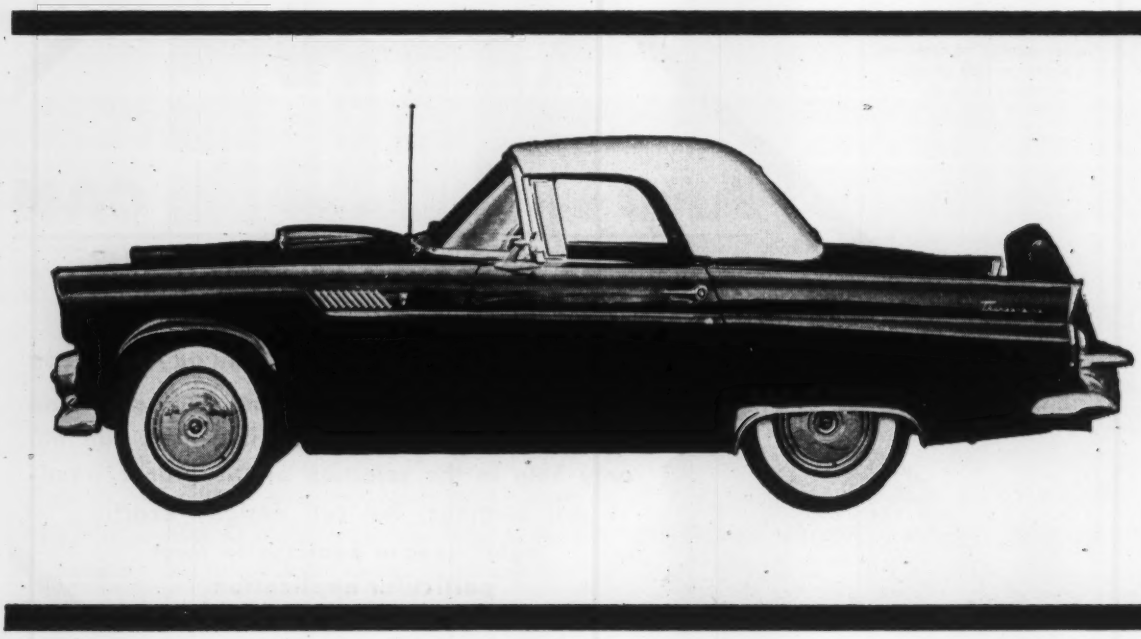
NICE BALL BEARING COMPANY

NICETOWN · PHILADELPHIA · PENNSYLVANIA

—ITEM 180—

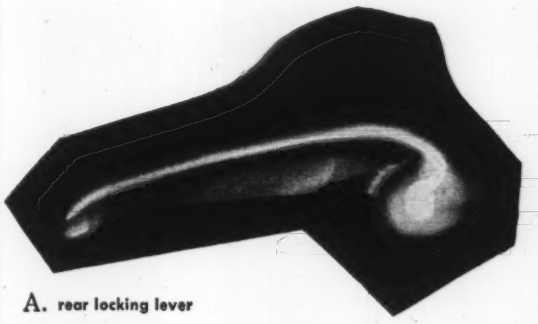
MUELLER BRASS CO. FORGINGS

give THUNDERBIRD tops a snug fit the year around



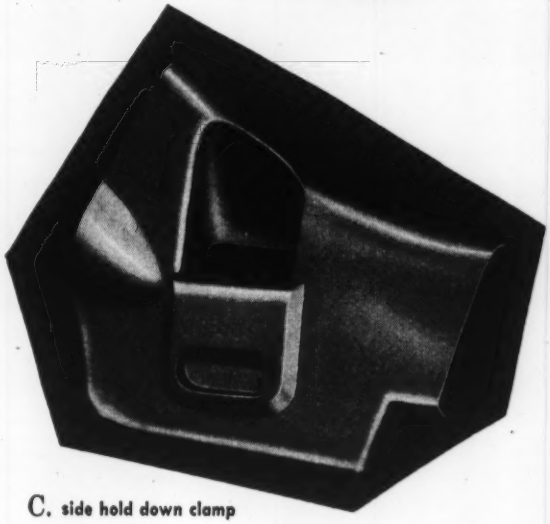
The Motor States Products Division of Detroit Harvester Co.—a major supplier of top assemblies for convertibles—has found Mueller Brass Co. forgings an ideal answer for securely fastening down the tops on the Ford Thunderbird. In a summer shower or in the snow of winter the top is always snug and draft-free. There are a pair of each of the three Mueller Brass Co. forgings shown here used in locking the Thunderbird top securely around the sides and rear deck. The locking lever (A) is incorporated in the top and operates a locking pin that fastens into the rear hold down clamp (B). A pair of side hold down clamps (C) are located just behind each door opening and clamp fasteners on the top hook into these forgings to rigidly hold the top in position. These forgings hold the necessary close tolerances and provide an excellent surface for buffing and chrome plating.

In addition, the price is favorable and deliveries are good. For these reasons, as well as their inherent strength and durability, a switch to Mueller Brass Co. forgings can prove advantageous. Write today for our engineering manual (No. H-58565) . . . or better yet, call in one of our engineers to investigate possible forging applications in your products.



A. rear locking lever

B. rear hold down clamp



C. side hold down clamp

WRITE TODAY FOR THE ENGINEERING MANUAL YOU NEED

Mueller Brass Co. Forgings
Engineering Manual H-58565 ☐

Tuf Stuf Aluminum Bronze Alloys
Engineering Manual H-58563 ☐

600 Series Bearing Alloys
Engineering Manual FM-3000 ☐

Copper Base Alloys in Rod Form
Engineering Manual FM-3010 ☐

METALS AND ALLOYS REVIEW

by FRANK M. LEVY, Director of Research

The other day one of our sales engineers stopped in to discuss gear applications and the subject got around to the amount of zinc permissable in gear and bearing alloys. Engineering books state that zinc is not desirable in bearing alloys. While this statement is true as regarding the commonly used copper-tin and copper-tin-lead alloys, it does not necessarily apply to other types of alloys. The 600 series bearing alloys, in which I am keenly interested, depend upon a high zinc content along with several other metal constituents to provide them with their fine bearing properties.

My explanation to our sales engineer was somewhat as follows: The question as to whether or not zinc is detrimental in a bearing alloy depends upon the remaining constituents in the alloy. A comparatively small amount of zinc is detrimental in a phosphor bronze alloy containing 80% copper, 10% tin and 10% lead. A zinc content of 4% is permissible in a bearing alloy containing 88% copper, 4% tin and 4% lead when used in an application not subject to heavy loads. In these alloys the tin combines with some of the copper to form a hard copper-tin constituent which is distributed through the soft copper matrix, or mat of copper. The higher the percentage of tin present, the greater the quantity of hard copper-tin constituent formed. Zinc also combines with copper increasing the hardness of the matrix. Therefore, when zinc is present along with a high tin content, the matrix becomes too hard and is "out of balance" resulting in poorer bearing qualities.

In the 600 series, copper, silicon, manganese, etc., are present with zinc. There is sufficient manganese present to combine with the silicon to form a purple manganese silicide which is embedded in the copper-zinc matrix. *Since the manganese-silicide constituent has a much higher micro hardness than the copper-tin constituent in phosphor bronze, the matrix of the 600 series alloys can have a higher hardness without impairing the bearing properties. In this instance, zinc is not detrimental but desirable because it produces an alloy with a high Brinell hardness which resists pounding and distortion.*

Like many engineers, we, too, were skeptical of the bearing properties of the first 600 alloy developed. A manufacturer of worm driven truck transmissions was having difficulty with the failure of chill cast high tin bronze gears in busses used in the hilly section of Los Angeles and Pittsburgh, and solved his problem by using gears made from 600 metal.

Since that time, we have had over a hundred successful applications on difficult bearing problems where cast bearing bronzes have failed. An interesting observation is that once a customer uses 600 alloys, he not only finds other applications, but continues to use it over a long period of years. Our original customers are still on our books.

In conclusion, we agree that zinc is detrimental to the bearing properties of the phosphor bronze type of alloys, but is of benefit to the 600 series alloys, *as it makes a harder matrix*, permitting the alloy to resist pounding action better than the softer phosphor bronze alloys.

I've just about run out of space for this time but we'll have another subject for discussion later. If you have any problems or questions about non-ferrous alloys, just write me here at Mueller Brass Co. and we'll see what we can do.

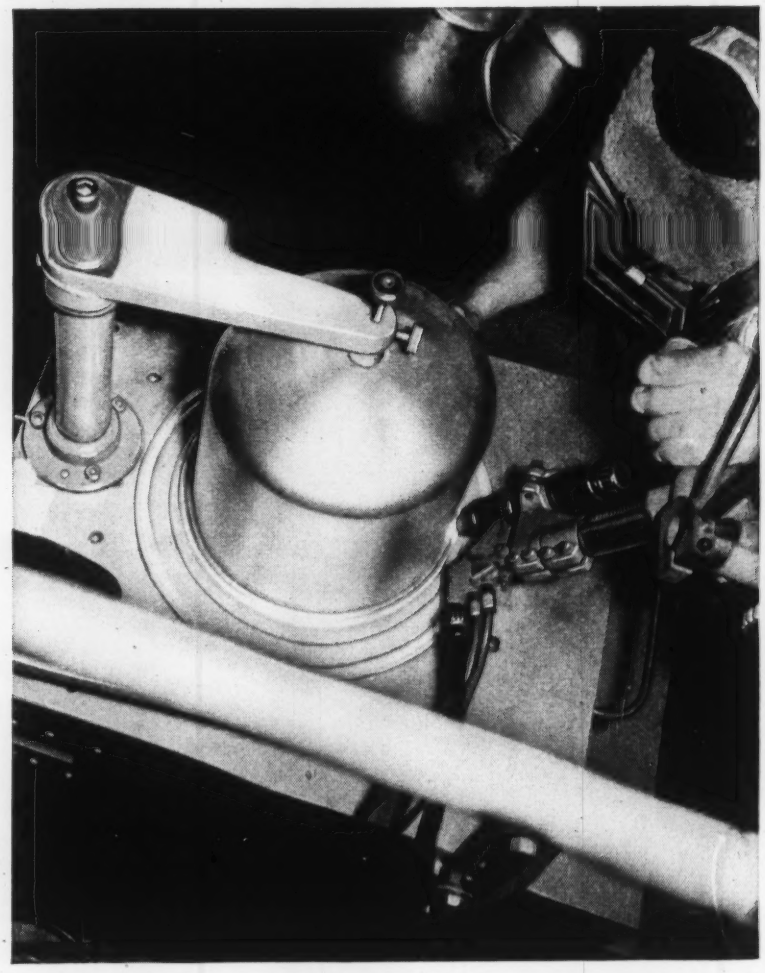
MUELLER BRASS CO.

PORT HURON 15, MICHIGAN

170

PRODUCTION *Zooms* 1000 PER CENT

with Mechanized HELIARC Welding



A HELIARC HW-13 torch is being used to weld a 18-in. aluminum radar cover.

A West Coast aircraft plant is using mechanized HELIARC welding to join the components of aluminum sealing covers for radar units—the "Seeing Eyes" of the Armed Services. Welding time has been cut from one hour and 10 minutes to only six minutes and the plant now turns out eleven covers in the same time it had formerly taken to produce one. Because the HELIARC welds are shielded from contamination by an inert gas, such as argon, they require no flux and are free from porosity and oxide inclusion. This results in fewer rejections and a minimum of finishing.

LINDE's team of welding processes—HELIARC, sigma, and UNIONMELT welding—can help you cut production costs and increase quality. Whatever your welding problem—one of LINDE's electric welding processes can do the job efficiently and economically. Call your local LINDE representative today for more information.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto
(formerly Dominion Oxygen Company)

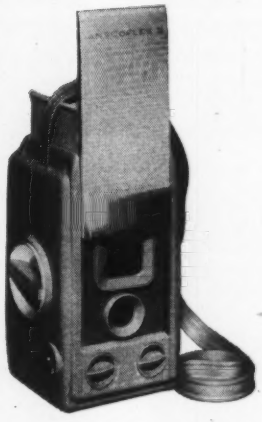
Linde Trade-Mark

"Heliarc," "Unionmelt" and "Linde" are registered trade-marks of Union Carbide and Carbon Corporation.

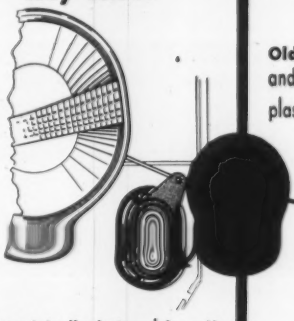
—ITEM 182—

5 Waldes Truarc Rings simplify assembly, eliminate parts, bring big over-all savings to new design low-cost camera

Anscoflex II Camera



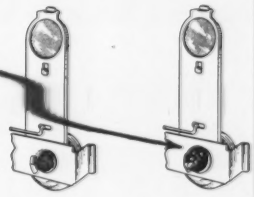
Key Shaft



Parts originally designed for self-locking Truarc ring (series 5105). Some cameras in the past had brass cup staked to the body. At times staking operation cracked the plastic, resulting in loss of expensive part.

Portrait and Filter Lens Knob Assemblies

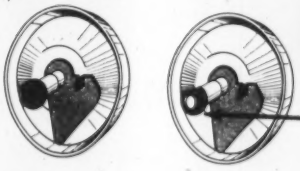
Old way: Knob with plastic shaft used washer and heat forming operation that flattened the plastic pin and locked the pivot in position.



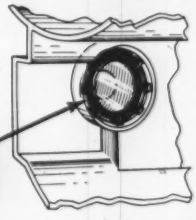
Truarc way: Molded plastic knob with pin is easily and quickly held by a Truarc self-locking ring (series 5105). No groove is necessary. Washer is eliminated and it is possible to remove ring if necessary without damage to knob.

Winding Knob

Old way: With screw and washer design, it was necessary to disassemble entire camera to remove screw which secured winding knob. Self-topping screw sometimes failed to secure knob, produced excessive end play.



Truarc way: Truarc "E" ring (series 5133) allows removal of winding knob without major disassembly of camera, reducing repair time. Use of stacked rings and Truarc applicator saved $10.40 per M on labor. Material saving: $2.29 per M.

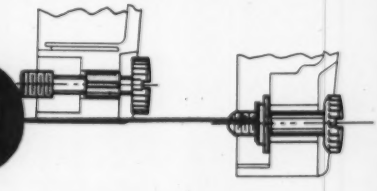


Rear Lens

Parts originally designed for self-locking Truarc ring (series 5005) Some cameras in the past had glass element secured by heat forming tabs from plastic body. Loose or chipped elements resulted in loss of both parts.

Flash-Gun Case Assembly

Old way: In the original design a sleeve was wrapped around neck of screw and pressed into hole of plastic cover. Close working areas made assembly difficult and required extra operation to lock ring into place.



Truarc way: Series 5133 E-Ring snaps onto unthreaded shank of screw quickly, needs no special groove. Labor saving $7.06/M.

Ansco, Binghamton, N. Y., uses the latest technical advances in construction to produce an economical, easy-to-use reflex camera. 5 Waldes Truarc Rings are used in this new design to save material and labor costs, eliminate parts, simplify assembly and reduce rejects.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting . . .Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES

TRUARC®

RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

*Name*_____

*Title*_____

*Company*_____

*Business Address*_____

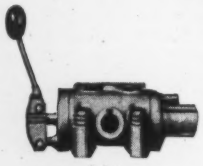
*City*_____ *Zone*____ *State*_____ MD018

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

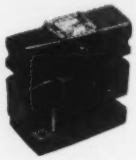
—ITEM 183—

"Why is it easy to plan Hydraulic Circuits using RIVETT VALVES?"

COMPLETE LINE



Hand, Foot, Cam, Solenoid, Pilot Operated



Sub-Plate Mounted, Solenoid, Pilot Operated

Flow Control, Check, Deceleration, Relief, Unloading, Sequence, Counter-Balance

1500-3000 P.S.I. | PISTON DESIGNS FOR ANY CIRCUIT

Sizes: 1/4", 3/8", 1/2", 3/4", 1", 1-1/4", 1-1/2"

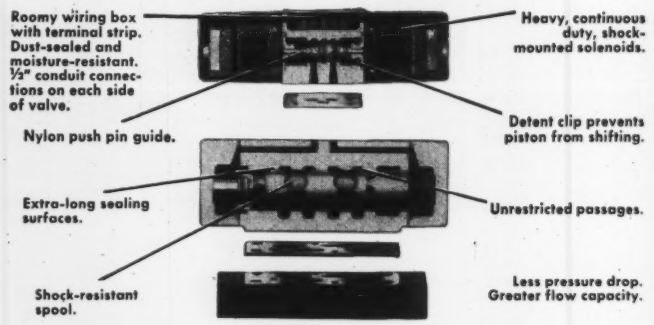
Actions: Standard, Spring Return, Spring Centered, Ball Detent

EXPERIENCED DISTRIBUTORS

"1st — Rivett's 190 standard models give me more latitude in engineering a circuit. This wide selection permits choosing the right type of valve for a more economical and efficient operation."

"2nd — My Rivett Distributor is experienced in hydraulic design. With his help I have been able to plan better operating systems."

QUALITY CONSTRUCTION


Roomy wiring box with terminal strip. Dust-sealed and moisture-resistant. ½" conduit connections on each side of valve.
Heavy, continuous duty, shock-mounted solenoids.
Nylon push pin guide.
Detent clip prevents piston from shifting.
Extra-long sealing surfaces.
Unrestricted passages.
Shock-resistant spool.
Less pressure drop. Greater flow capacity.

Sub-Plate Mounted, Solenoid, Pilot Operated Valve

INFORMATIVE LITERATURE

"3rd — I can count on longer life as well as the rated performance of Rivett Valves. They are designed and built for accurate circuit control."

"4th — Rivett valve catalogs are complete with specifications and drawings. Write for #204 and #260."

RIVETT LATHE & GRINDER, INC., DEPT. MD-1 BRIGHTON 35, BOSTON, MASSACHUSETTS

RIVETT furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

Member—National Fluid Power Association

—ITEM 184—

For More Information Circle Item Number on Yellow Card—page 19

Checking contact and backlash of a production gear set at the De Laval Steam Turbine Company.

How to Save in Selecting Worm Gear Sets

By James E. Gutzwiller, *Assistant Chief Engineer, Worm Gearing Department*

De Laval Steam Turbine Company

Worm gear sets have four major advantages: compactness, easy maintenance, interchangeable components, and high shock-load capacity. The user can realize maximum benefits from these advantages and reduce costs by acquiring some background information on the characteristics of worm gearing. Here are a few points to consider.

Standard Components. Find out what standard components are available before proceeding with design. De Laval stock parts include worms, gears, bearing housings and end covers. By selecting from these, the user may sharply reduce the cost of the finished gear set.

HOBBING MACHINE — Tangential feed gives uniform teeth of precise dimensions. This is accepted as the most satisfactory method for producing close tolerance worm gearing.

The hob, for example, must match the pitch diameter, pitch, lead and tooth form of the worm. Designers who are familiar with standard hobs can design a worm accordingly and save the expense and delay of obtaining a special hob.

A Note on Assembly. The worm, having threads which are continuous in form, is not critical in regard to endwise location. The gear, however, must be precisely positioned in an axial position. Accumulation of tolerances on the dimensions of housings, shafts, bearings and gears makes it impractical, in most cases, to control the location of the gear by accuracy of machining alone.

Shrouding. Heat developed in the gearing will be more freely dissipated through a comparatively open housing. Close shrouding is permissible only when intermittent operation is the rule.

Helpful Manual on Worm Gear Sets

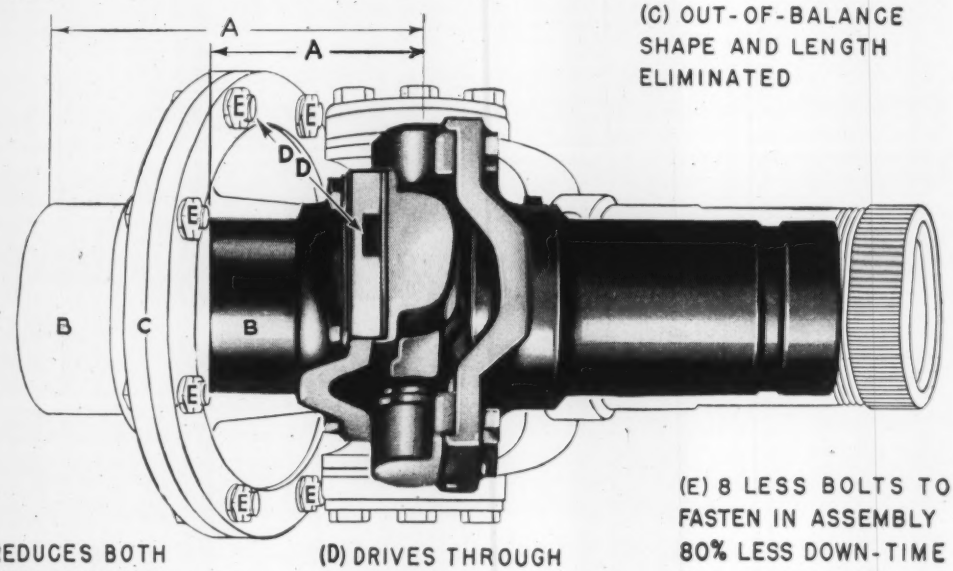
For information on how to select, install and maintain worm gear sets, send for this helpful manual. It contains useful data on gearing and includes examples of specific selection problems with their solutions. Write on your business letterhead to the De Laval Steam Turbine Company, 858 Nottingham Way, Trenton 2, N. J. for Catalog 5000.

You Are PAYING For MECHANICS JOINTS

Every time you use a joint that requires unnecessary attachments and extra assembly time and labor, you are paying for MECHANICS advantages — but are not getting the benefit of them. You force your truck or other product to carry unnecessary DEADWEIGHT instead of PAYLOAD. And don't settle for

(A) BRINGS BEARINGS IN THE JOINT CLOSER TO BEARINGS IN TRANSMISSION AND AXLE

(C) OUT-OF-BALANCE SHAPE AND LENGTH ELIMINATED



(B) REDUCES BOTH WEIGHT AND SIZE BY ELIMINATING THE FLANGE

(D) DRIVES THROUGH KEYS-FOR SAFETY AND LONGER LIFE

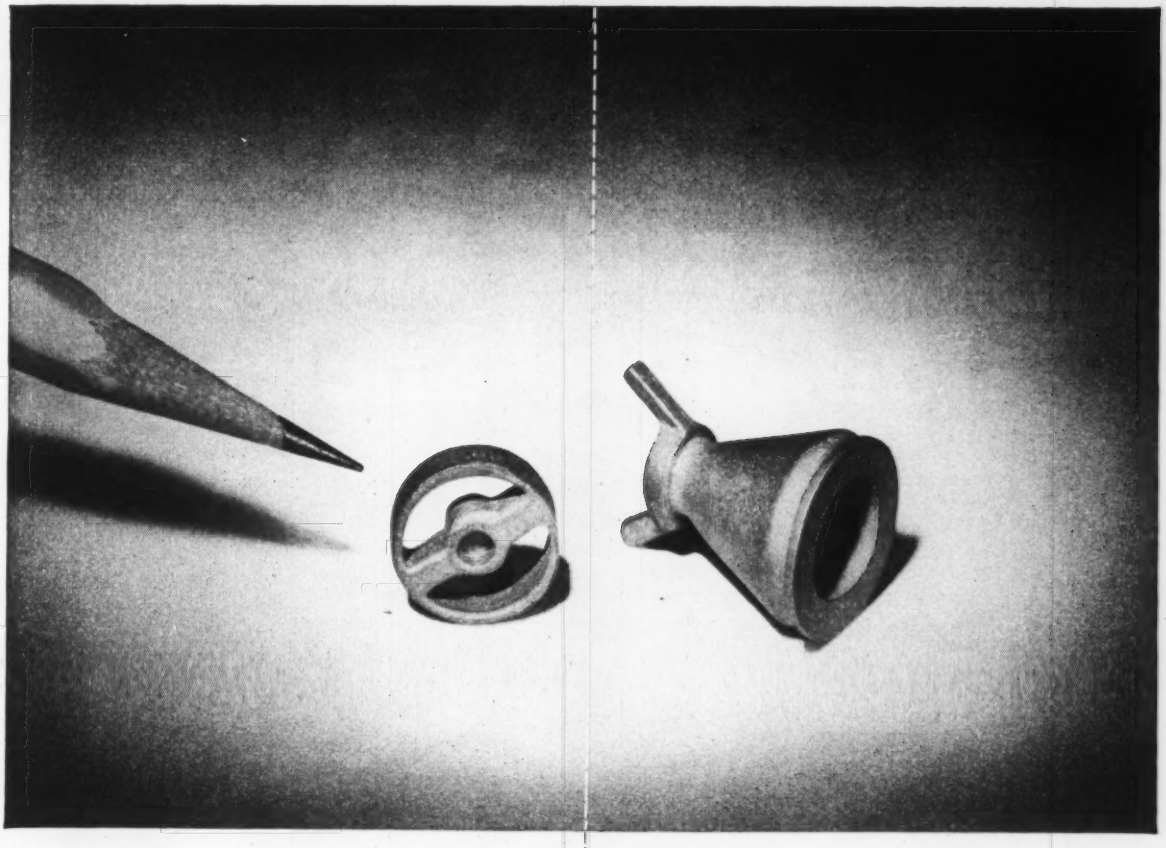
(E) 8 LESS BOLTS TO FASTEN IN ASSEMBLY 80% LESS DOWN-TIME FOR SERVICING

"Mechanics TYPE" — joints — let our engineers explain how genuine MECHANICS joints will give your product competitive advantages.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2032 Harrison Avenue Rockford, Illinois

Why Not Give YOUR Truck MECHANICS Advantages?

—ITEM 185—
For More Information Circle Item Number on Yellow Card—page 19



30% Saving American Machine and Metals, Inc., of Sellersville, Pa., manufactures the AutoBAR liquor dispensing system. This collet head is part of the locking mechanism.

15% Saving This collet spreader is used to lock the assembly in the neck of the bottle. Both parts shown above are twice life-size.

How Inco Precision Casting Cuts Costs

Look at these two small parts. Important to the AutoBAR liquor dispensing system, they are precision investment cast. But this wasn't always so —

When the collet head was machined from Inconel* nickel-chromium alloy bar stock it required ten costly operations—and about half the bar was machined away as scrap. Now Inco precision cast, it needs only lapping and drilling of one hole—cutting cost 30%!

And the collet spreader, when machined from bar stock, required three parts which had to be brazed together. It is now precision cast in one piece requiring only drilling and lapping one hole – cost is cut 15%.

On both parts a tolerance of plus or minus .003 inch per linear inch was held! Unusually close tolerances like this often can be held on small parts by Inco precision casting specialists.

All metal parts that come in contact with the liquor are made of Inconel nickel-chromium alloy or "K"* Monel age-hardenable nickel-copper alloy to protect color and flavor.

Can You Cut Costs with Inco Precision Castings?

Whenever you have a part which is 6 inches x 5 inches or smaller, weighs under 3 lbs., requires starting tolerances as close as plus or minus .005 inch per linear inch, and needs 5 or more fabrication steps, there's a good chance you can save by having it precision cast.

* * *

What Alloys Can Be Precision Cast?

You may obtain precision castings from Inco in many metals and alloys from plain carbon steel to the new super alloys. And no matter what metal you specify, you get many advantages.

*Registered Trademark

5 Advantages of Inco Precision Castings

- Save up to 60% of production costs.
- Longer life with harder alloys.
- Little or no machining required.
- Wider design latitude.
- Higher alloys at lower cost.

Get This Helpful New Booklet

Trying to keep costs in line on some small part? Then write for new 16-page booklet, "Cast to Outlast." Contains many case histories detailing how others cut costs with Inco precision castings. There is a good chance this helpful data will suggest a practical way to cut your costs, too.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO Nickel Alloys

Inco Castings . . . Precision, Sand, Centrifugal

Here's the Complete "Package"

for Counting Electrically...

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This Veeder-Root Reset Magnetic Counter (AC or DC) is actuated through electromagnets. And it may be connected in series with any device having a contact arrangement . . . like the specially designed Veeder-Root Electrical Contactor at the left, which insures positive operation of the counter, either in oscillation or connected directly to a revolving shaft . . . with the counter placed at *any* distance from the machine or process on which the count is required.

This is another one of the hundreds of Veeder-Root Standard and Special Counting and Computing Devices developed for every conceivable counting duty, in every field from atomics to electronics.

What do *you* need to count? Just write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada •
Offices and Agents in Principal Cities
"The Name that Counts"

—ITEM 187—
For More Information Circle Item Number on Yellow Card—page 19

The steel that could take anything but a bath

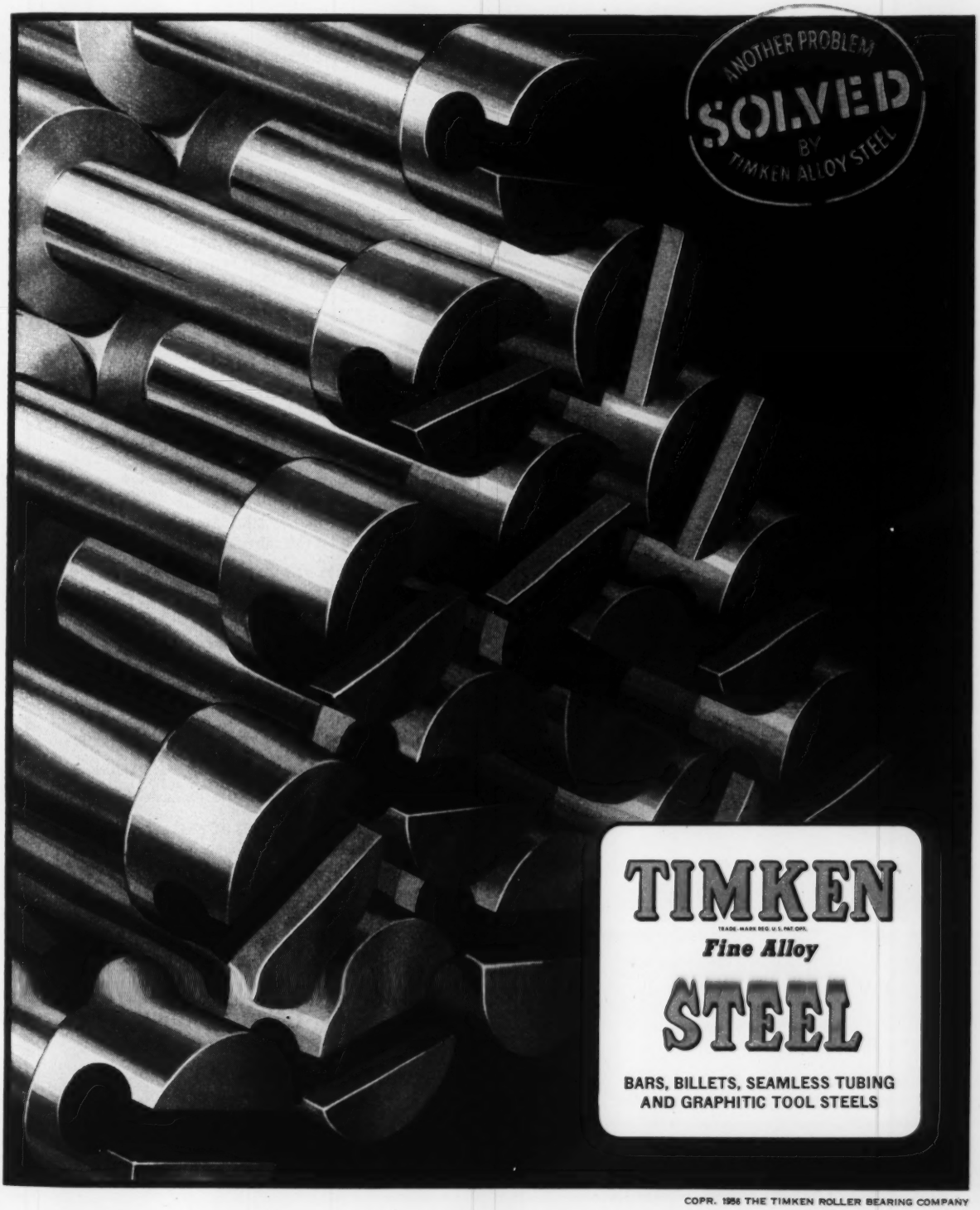
IN steel mills and warehouses, a roller leveler straightens wide sheets and heavy plates between powerful steel rolls and shoots them out flat and level.

As you can imagine, the stress on the rolls is tremendous. To make them strong enough and tough enough, one roll manufacturer was using an alloy steel, 52100. Then to make the rolls *hard* enough, they were heated to a high temperature and quenched in a liquid bath. But the severe quench was causing many of the rolls to warp.

The roll maker brought his problem to metallurgists of the Timken Company. "Could rolls be made from 52100 steel that wouldn't distort in quenching?" Their considered answer: Yes—if the steel were uniform, from lot to lot, in analysis and hardenability.

So the roll maker changed to 52100 steel made by the Timken Company. They found the steel *was* uniform—lot to lot . . . heat to heat . . . year in, year out. The roll maker was able to standardize his heat-treating practice. Since the change to Timken steel, distortion has been practically eliminated.

Our files bulge with scores of problems that have been "Solved—by Timken Alloy Steel". Can we help solve a steel problem for you? Write: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Tapered Roller Bearings, Alloy Steels and Seamless Tubing, Removable Rock Bits.



COPR. 1956 THE TIMKEN ROLLER BEARING COMPANY

Aeroquip's New 64-Page

EACH SECTION CONTAINS HELPFUL INFORMATION!

SECTION A contains the following engineering data and equipment:

products and services
ordering instructions
hose fluid reference chart
planning of hose installations
bend radius vs. operating pressures
vacuum data
thread interchange data
bulkhead hole size data
hand tools
support clamps
hose cover stripping tool
hose cut-off machine
hose assembly machines
hydrauliscope

SECTION B contains the following hose, fittings and adapters:

low, medium, high and very high pressure hose lines
air brake hose
coal shooting hose
grease hose
ammonia hose
LPG hose
steam hose
trichlorethylene hose
diesel fuel hose
Freon hose
hot water hose
low temperature hose
electrically non-conductive hose
fire-resistant hose
S.A.E., J.I.C., Parker, and Union adapters
assembly combinations chart
assembly instructions
kits

SECTION C contains the following special fittings:

flange type, split flange type and Globe Seal fittings.

SECTION D contains the following Self-Sealing Couplings:

industrial and farm Self-Sealing Couplings, and farm Breakaway Coupling.

NO COST TO YOU . . . JUST FILL IN AND MAIL THIS COUPON

Aeroquip Corporation, Jackson, Michigan

Gentlemen:
Please send me the new, illustrated Aeroquip catalog checked at the right.

- ☐ Industrial No. 200
- ☐ Aircraft No. 100
- ☐ Marine No. 300

Name_____

Title_____

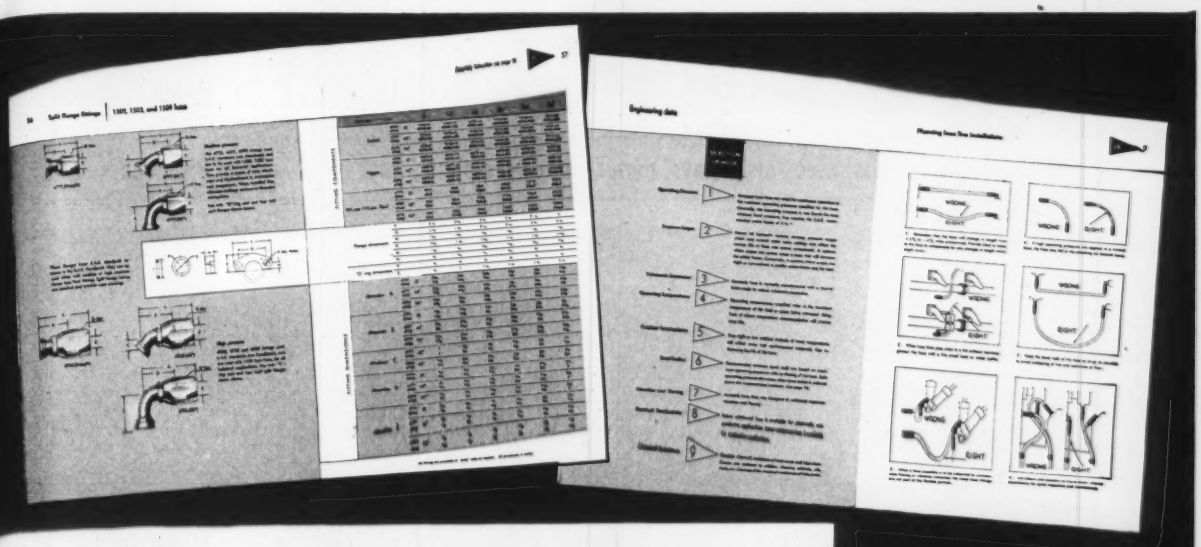
Company_____

Address_____

City_____ Zone____ State_____

Get Your Copy Now... Fill In and Mail This Coupon Today!

For More Information Circle Item Number on Yellow Card—page 19



Industrial Catalog Is Ready!

YOU'VE NEVER SEEN A HOSE LINE AND COUPLING CATALOG THAT IS SO COMPLETE . . . SO EASY TO USE . . . SO PACKED WITH HELPFUL INFORMATION!

Whether you design machine tools, trucks, construction equipment, engines, farm equipment, or any of hundreds of industrial products, this new Aeroquip catalog will save you hours of time . . . provide answers to knotty fluid line problems.

The full range of products covered includes hose, fittings and couplings for everything from low to extra high pressure systems . . . for carrying hydraulic fluid, air, grease, oils, ammonia, LPG, steam, diesel fuel, Freon, water and many other fluids. You will also find valuable reference to help you in the planning, engineering, and installation of fluid-carrying systems.

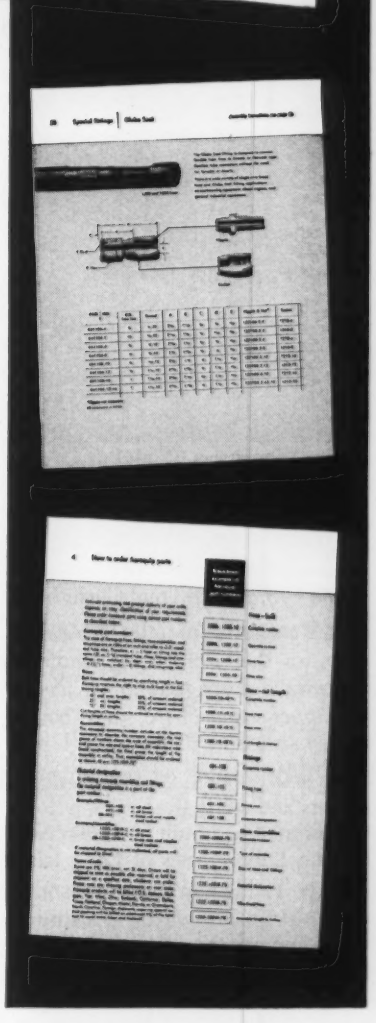
Aeroquip's new, fully illustrated catalog No. 200 is designed to be easily read and exceptionally easy to use. Be sure to get your copy. Fill in and mail the handy coupon today!

ALSO AVAILABLE! TWO OTHER NEW AEROQUIP FLEXIBLE HOSE LINE AND COUPLING CATALOGS

Catalog No. 100 covering aircraft products.....(78 pages).

Catalog No. 300 covering marine products.....(40 pages).

Please check box in coupon for catalog desired.



Support Junior Achievement

Junior Achievement Week, January 29-February 4

Aeroquip

REG. TRADEMARK

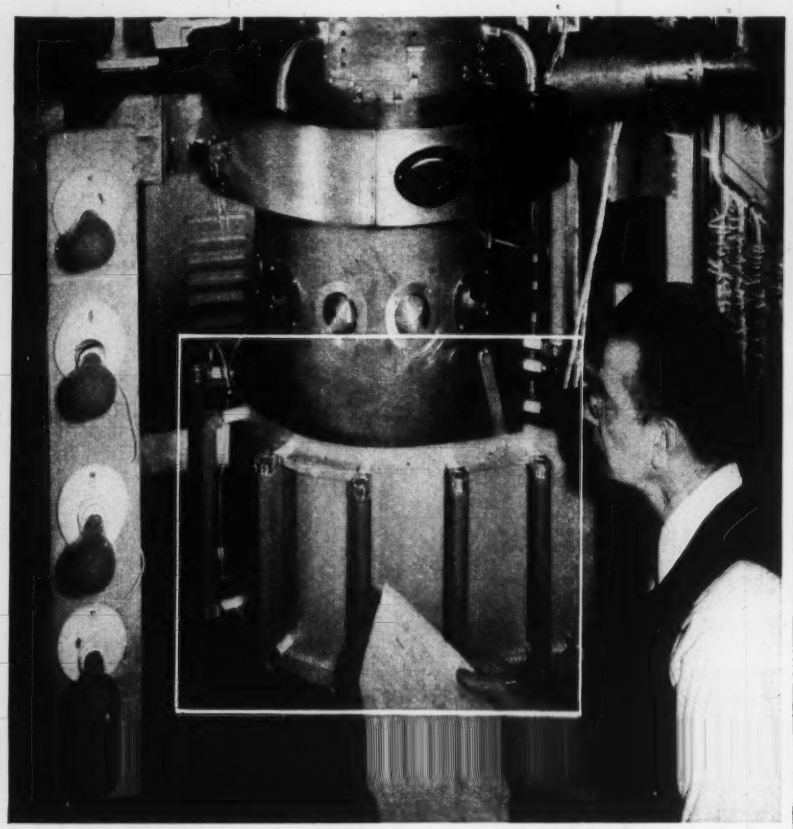
AEROQUIP CORPORATION, JACKSON, MICHIGAN

LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

—ITEM 189—

★ Control Components Digest ★

News and notes on resistors, rheostats, relays, motor controls, dimmers and other control components



BIG MOON RADAR undergoing tests. Ward Leonard resistors—like those in foreground—help this gear stay on the air—or, rather, on space.

New moon radar to explore outer space

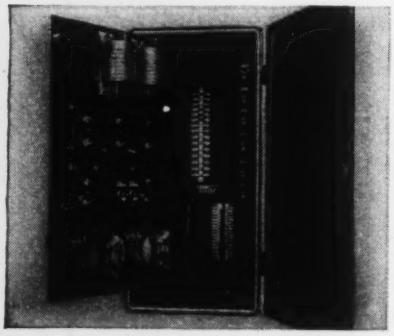
The U.S. Army Signal Corps hasn't got a transmitter in outer space—yet.

So, for their continuing studies of radio wave propagation in space and the upper atmosphere, they bounce radio waves from their new high-powered radar, Diana, off the moon and planets and study the return pulse.

Designed and built by Radio Engineering Laboratories of Long Island City, N. Y., the new radar transmitter puts out 50 kilowatts, continuous wave, and may be pulse modulated at various pulse widths and repetition rates. Receiver gain is 170-db at better than 3-db noise figure.

Throughout the equipment, high-stability Ward Leonard resistors, like the big Vitrohm resistors shown above, do duty as high-voltage bleeders, surge and current limiting resistors, and protective meter shunts in high-voltage circuits.

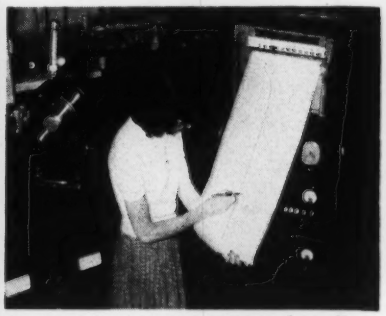
You'll find Ward Leonard Vitrohm resistors completely described in our 64-page Catalog No. 15, together with nomographs and charts to help select them. Write for your copy today.



Relays mastermind traffic lights

Sun, rain, sleet, snow, and continuous 24-hour-a-day duty is the lot of this master traffic light controller. Four dependable Ward Leonard relays select automatic timing cycles. Two more relays allow remote control of off-duty flashing amber signals and signal shut-down. Learn more about these rugged relays in Ward Leonard Bulletin No. 110.

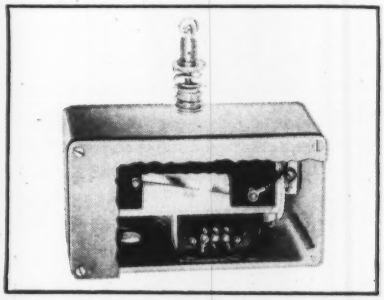
Photo courtesy Crouse-Hinds Co.



SHE'S CHECKING CHART RECORD from X-ray spectrometer in Ward Leonard's test lab.

Plant X-ray speeds quality control and helps catch crooks

X-ray diffractometer and spectrometer tests insure high quality and uniformity of both raw materials and fabricated components at Ward Leonard. These instruments check crystal structure in ceramics, magnetic amplifier cores, contact metal, and resistance wire. In off hours, they help the Mount Vernon Police and Fire Department put the finger on crooks and arsonists.



AUTOMATION FOR MACHINE TOOLS is simplified by this precision control potentiometer.

Control for machine tools

Accurate electronic control component for cutting tools, winders and processing machine drives is provided by this compact, precision potentiometer.

A half-inch plunger movement drives the metal alloy contact across the special resistance element. Enclosure is compact; calibration is permanent. Standard resistance—10,000 ohms; up to 25,000 ohms on special order. Write for Bulletin 68. 63

WARD LEONARD ELECTRIC COMPANY
58 SOUTH ST., MOUNT VERNON, N. Y.

Result-Engineered Controls Since 1892

RESISTORS · RHEOSTATS · RELAYS · CONTROLS · DIMMERS

—ITEM 190—

For More Information Circle Item Number on Yellow Card—page 19

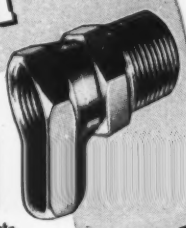
Designers and Engineers... Clip these reminders to specify

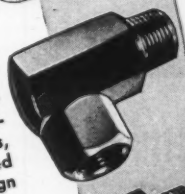
Eastman
first in the field

HYDRAULIC HOSE ASSEMBLIES

Stop torsional strain with Eastman ADAPTER UNIONS

Eastman Design and Engineering
Guarantees Tight Fit . . . Easy Action





Straight and Angled Adapter Unions

- **Eastman Adapter Unions** prevent twisting and assure proper positioning of hose lines when being installed. Accurate machining assures leakproof metal-to-metal seat as effective as a ground joint union.
- **Eastman Angled Adapter Unions** eliminate the use of elbows and pipe unions, thereby reducing the number of threaded connections. Original Eastman design provides tight-fitting joint at any pressure.
- **Eastman, "First in the Field of Hydraulic Hose Assemblies,"** stands for the highest quality of material and workmanship—your best assurance of satisfactory service.

"Safeguarding Industry's Lifelines of Mobile Power"

EASTMAN MANUFACTURING CO.
Since 1914
Dept. PE54, Manitowoc, Wisconsin

Eastman
first in the field
HYDRAULIC HOSE ASSEMBLIES

Send for Eastman Form No. 231-B, 232-B for sizes, angles available.

Specify Eastman HYDRAULIC HOSE ASSEMBLIES

Profit from Eastman's 26 years' experience in Hydraulic Hose Assemblies. Pressed-on and re-usable renewable couplings and sert type fittings for high and low pressure air, gas, water, paint, grease and hydraulic hose...from 1/8" to 2". Pressure lines up to 5000 psi. Also suction and low pressure units.

WRITE FOR COMPLETE CATALOG OR PHONE YOUR SPECIFICATIONS

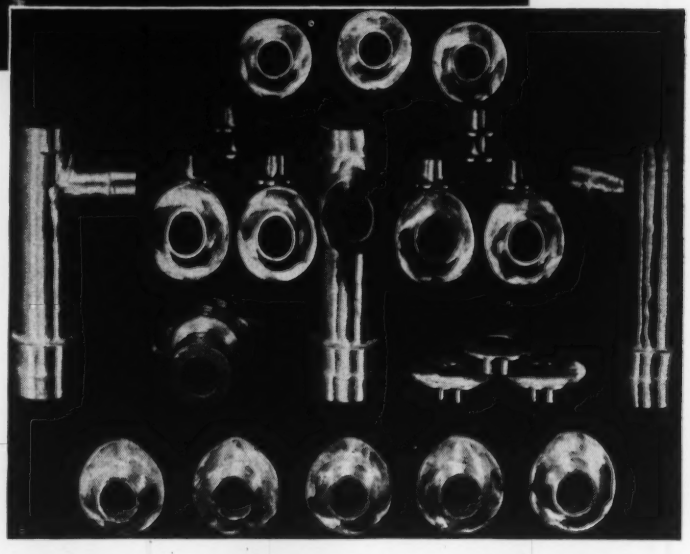
EASTMAN MANUFACTURING CO.
Since 1914
Dept. PE54, Manitowoc, Wisconsin

Eastman
first in the field
HYDRAULIC HOSE ASSEMBLIES

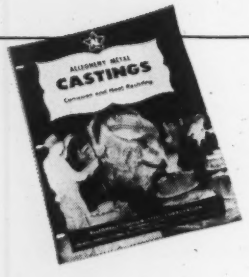
SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

Write for free catalog 104 on Eastman Hose Couplings and Bulletins 231B & 232B on Straight and Angled Adapter Unions

Eastman
MANUFACTURING COMPANY
Since 1914
Dept. MD-1, Manitowoc, Wisconsin



This is the mark that means clean, sound Stainless Castings all the time



Write for your copy: "ALLEGHENY METAL CASTINGS"

32 pages of valuable and complete data on stainless castings: analyses, properties, technical data on handling and heat treatment, typical applications, how to order, etc.

ADDRESS DEPT. MD-73

Every stainless casting produced by our Buffalo Foundry carries the familiar "AL Star" trademark, cast into the steel. That means it's *Allegheny Metal,* the time-tested stainless steel—a pioneer that has successfully answered thousands of difficult corrosion and heat resisting problems.

It not only means experience in stainless casting applications, but in maintained high quality, too. The A-L Buffalo Foundry is a pioneer in both the vertical-centrifugal and static methods of casting stainless steel. You can depend upon Allegheny Metal Stainless Castings to be strong, clean-surfaced, sound-structured and easy-machining . . . fully in accord with the service conditions and with your requirements for delivery.

Let our stainless foundry specialists quote on *your* problem jobs—any shape casting or any size, up to thousands of pounds. ● *Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.*

WAD 8007 B

For Stainless Steel in ALL Forms—call

Allegheny Ludlum

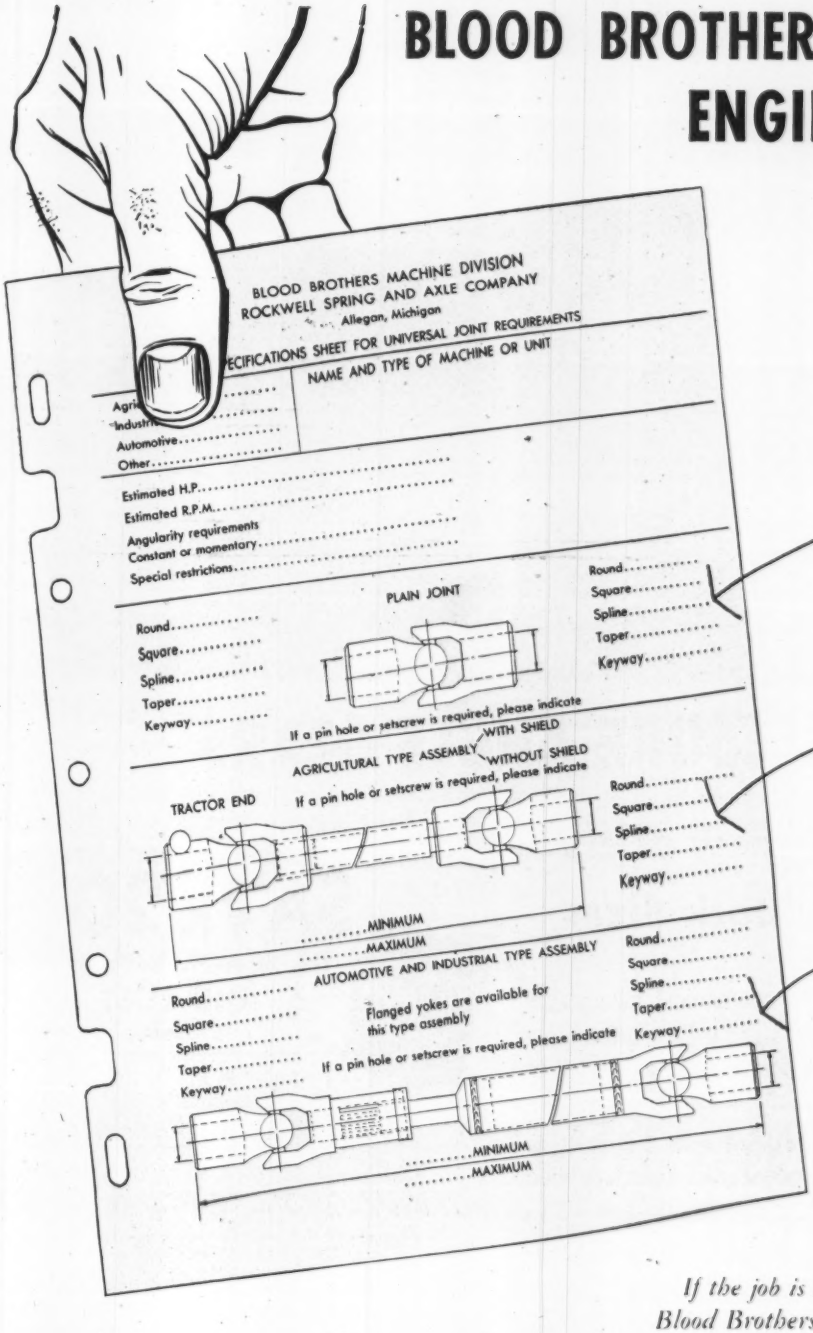
Warehouse stocks carried by all Ryerson Steel plants

AL® STAINLESS STEEL

—ITEM 192—

For More Information Circle Item Number on Yellow Card—page 19

BLOOD BROTHERS makes your ENGINEERING JOB *EASIER*



. . . regardless of whether your project requires a single universal joint such as this

. . . a complete agricultural type assembly

. . . or an automotive or industrial truck propeller shaft like this

Just fill out and mail a sheet like *THIS*—and let BLOOD BROTHERS' Engineers propose a helpful, practical solution to your Drive Line Problem!

If the job is unusual or the problem unique. Blood Brothers' experience can be invaluable.

Many engineers are saving valuable time—right at the start of a project—by filling out and returning a "Spec Sheet" like this to Blood Brothers. Why not try it?

With your power transmission requirements in mind, our engineers will make recommendations and submit engineering drawings. You save designing and drafting time, and perhaps forestall problems, by having the initial teamwork of experienced specialists.

This service is offered without extra charge because *we* can work more efficiently with all the facts in hand.

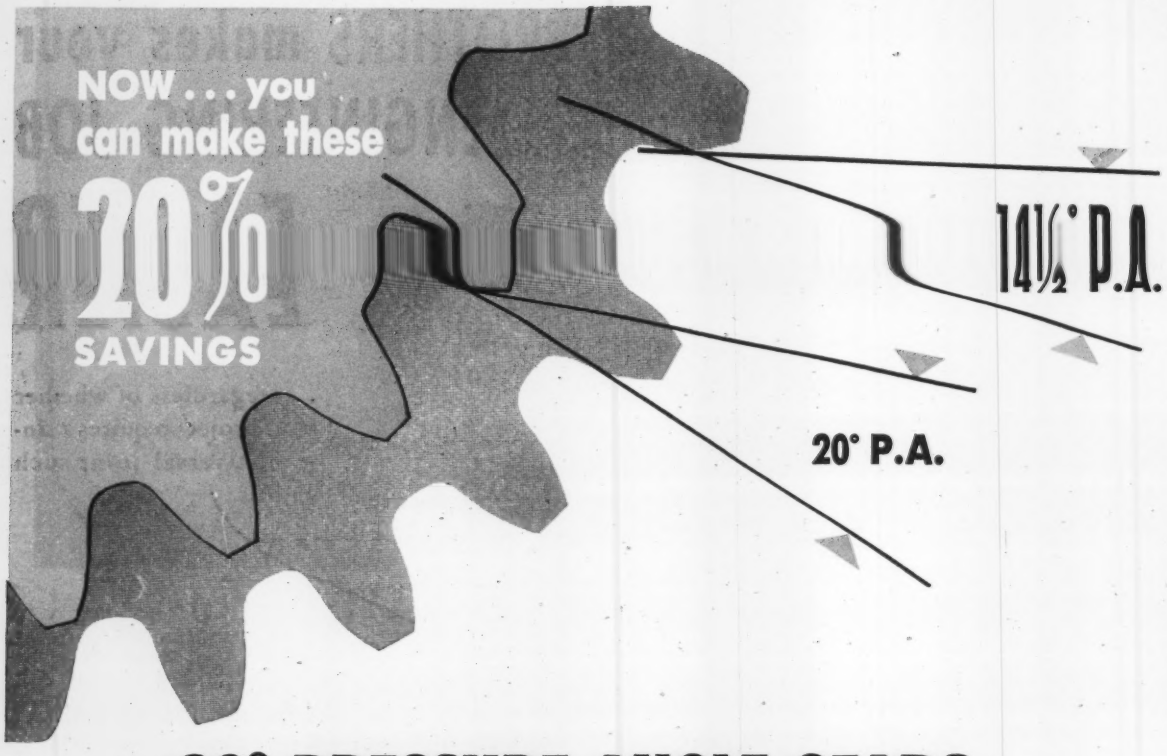
Blood Brothers builds *more standard types and sizes* of universal joints than any other manufacturer (from 300 up to 89,300 torque inch pounds continuous load).

Why not use this experience on your next project? *Write Blood Brothers today for your handy "Spec Sheets."*

BLOOD BROTHERS MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

—ITEM 193—



with 20° PRESSURE ANGLE GEARS

BOSTON GEAR now offers 441 Standard Stock Sizes

Every engineer knows the mechanical advantages of the 20° P.A. tooth form. It's the standard for automotive drives, and wherever highest efficiency, with economy of space, weight, and cost are essential.

Now, BOSTON GEAR has the answer to the question of *availability*. A full range of *standard stock* sizes, supplied by all BOSTON GEAR Distributors, makes it practical to specify the 20° P.A. for virtually all spur, bevel, and miter gear applications.

Start making this big saving you've been missing. For details, call your BOSTON GEAR Distributor, or write: Boston Gear Works, 64 Hayward St., Quincy 71, Mass.

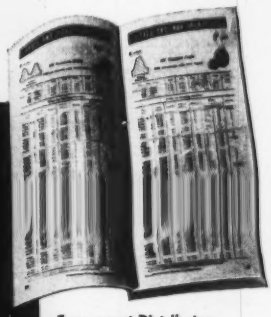
COMPARE: SAME RATIO SAME HP

SAVE 20%
IN SPACE, WEIGHT, AND COST

Example:

	14½° P.A.		20° P.A.	
	Pinion	Gear	Pinion	Gear
Pitch Diam.	2"	8.4"	1.66"	7.00"
Center Distance	5.200		4.333	
Weight	1 lb.	7½ lbs.	¾ lbs.	5 lbs.
List Price	1.95	8.65	1.70	6.70

BOSTON GEAR CATALOG lists Standard Stock Sizes of 20° P.A. Spur, Bevel, and Miter Gears, along with the conventional 14½° P.A. Gears for every requirement. Ask for your copy.



Call your BOSTON Gear DISTRIBUTOR

For nearest Distributor, look under "GEARS", in the Yellow Section of your Telephone Directory

7124 "OFF-THE-SHELF" TRANSMISSION PRODUCTS FROM YOUR LOCAL DISTRIBUTOR — AT FACTORY PRICES

568G-G-18

FOR SCUFF-RESISTANT BEAUTY. This Sunroc water cooler has, as standard equipment, a Stainless Steel kick plate for protection against scuffing and corrosion when floors are mopped. The deep drawn top is also made from Stainless. It's bright and inviting, and easy to clean.

FOR LONG, HARD SERVICE. Some of the Stainless Steel tubes in this bundle are 20 years old, despite the fact that they have been in continual service in a thermal cracking unit at a major southwestern oil refinery. Even though some of them have been lengthened by heliarc welding, they still retain their ability to handle corrosive products.

NOTHING *can equal* *Stainless Steel*

FOR SANITATION. This is a Stainless Steel rotary washer at a baby food plant of Gerber Products Company. Stainless Steel was used because of its great corrosion resistance, because it will not contaminate the food products, because it is so very easy to clean. Gerber's uses a lot of Stainless Steel processing equipment—including peelers, bins, steamers, holding tanks and filling machines.

• No other design material can match Stainless Steel in its *combination* of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers the widest range of types, finishes and sizes available in the United States.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

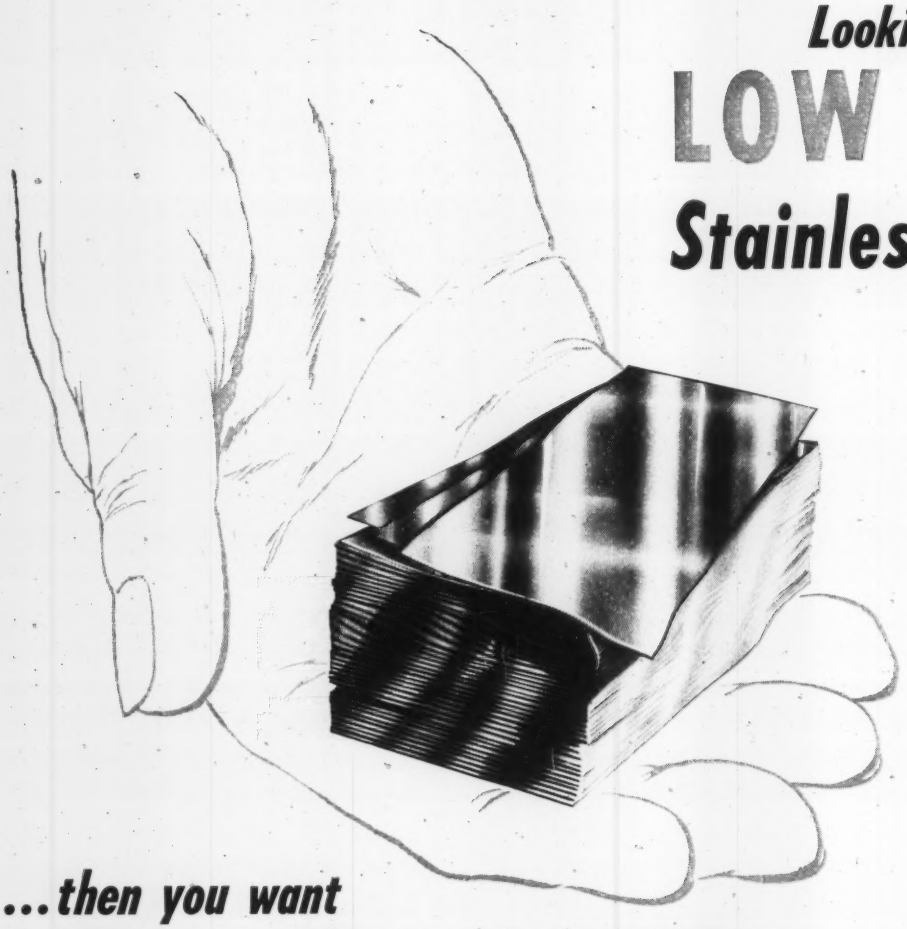
USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

UNITED STATES STEEL

Looking For
LOW COST
Stainless Steel?



...then you want
MicroRold® 430 Sheet

Perhaps you have always thought of stainless steel as a luxury material and out of the question as far as your product is concerned . . . or maybe you have seriously considered using stainless steel only to find its cost prohibitive . . .

True, some grades of stainless steel are relatively expensive, but this is because they possess higher degrees of corrosion resistance, absolutely necessary in some highly corrosive applications. This is not the complete story, however, as there are other less expensive grades of stainless having sufficient corrosion resistance without sacrificing the other desirable stainless steel qualities of beauty, strength, long life, workability and ease of maintenance.

If extreme corrosion resistance is not a factor in your product, it would be unnecessary and costly to specify a higher grade of stainless than required.

This is where MicroRold 430 enters the profit picture...

MicroRold Type 430 is a straight chromium-stainless with a nominal composition of 17% chromium. Though it is less resistant to corrosion, it retains all of the other desirable qualities of stainless and has proven very satisfactory in a wide range of mild corrosion applications.

MicroRold 430 is the least expensive of our stainless types because it does not contain nickel. This results in a 7¾c per pound difference in base price between Type 430 and Type 302, the most popular higher grade stainless. A saving of $155 per ton is possible and is of merit to cost-conscious fabricators.

MicroRold Type 430 sheets are available in thicknesses .005" to .109" with 2B or 2D finishes; and in thicknesses .010" to .109" in No. 3, 4 and 7 finishes.

Send for your copy, "Care and Use of 430 Stainless"

Washington Steel
Corporation

WASHINGTON STEEL CORPORATION — MicroRold — STAINLESS SHEET & STRIP

1-E WOODLAND AVE. WASHINGTON, PENNSYLVANIA

—ITEM 196—

For More Information Circle Item Number on Yellow Card—page 19

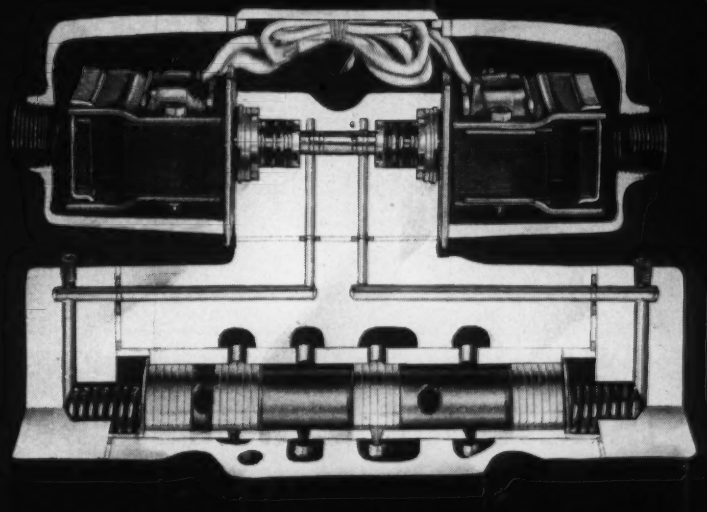
A product of

and

NEW **RACINE**

Twin Solenoid — Pilot Operated

4-WAY VALVE



Balanced Piston -- Sleeve Type -- 2000 psi Working Pressure

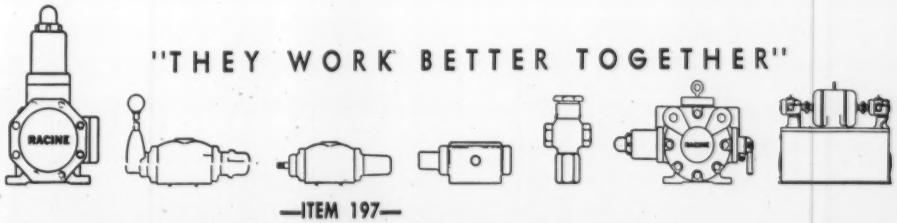
This design offers Solenoid Control, Pilot Operation, Subplate mounting, and allows unusual versatility with conversion to either spring centered, spring offset, or no spring. Solenoids are enclosed and secured to the valve in removable dust proof covers. Electrical operation is prevented when the covers are not in place. This feature promotes safety, and contributes to low maintenance.

Large openings permit a maximum flow of oil through the valve at a minimum pressure drop. This valve conforms to J. I. C. specifications and standards.

Write for catalog giving complete details and features. Address **RACINE HYDRAULICS & MACHINERY, INC.,** 2073 Albert St., Racine, Wisconsin.

STANDARD FOR QUALITY AND PRECISION · RACINE HYDRAULICS & MACHINERY, INC. · RACINE

"THEY WORK BETTER TOGETHER"



—ITEM 197—

MULTIMET alloy wraps are joined by welding in the fabrication of aircraft cabin heaters.

MULTIMET Alloy Wraps
Absorb the Heat from a 3500 deg. F Flame

MULTIMET alloy wraps are used to absorb the intense heat from burning aviation gasoline in aircraft cabin heaters. The spirally wrapped alloy sheet transfers the combustion heat to fresh ventilating air. Very thin sheet — only 0.025 in. thick—does an excellent job here despite the high metal temperatures and the oxidizing conditions.

Rigorous 1,000-hr. tests were conducted before MULTIMET alloy was selected for this job. It has now been the standard material for seven years. The excellent high-temperature properties of the alloy made it possible for designers to use thin sections, which insure a light, compact heater, with excellent heat-transfer efficiency.

MULTIMET alloy is one of many HAYNES high-temperature alloys for economical use over a wide range of operating conditions. It has given good service for engine manifolds, turbine blading, heat-treating equipment and many aircraft components. For a copy of a booklet describing HAYNES high-temperature alloys, and for prices and sizes of MULTIMET alloy, get in touch with the nearest Haynes Stellite Company office.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Haynes" and "Multimet" are registered trade-marks of Union Carbide and Carbon Corporation.

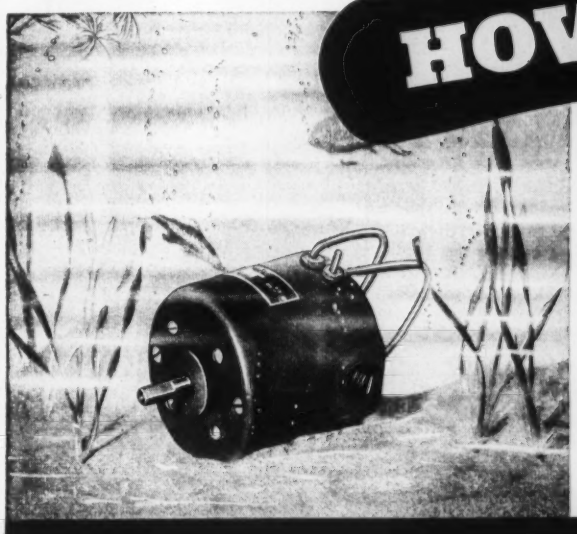
—ITEM 198—

For More Information Circle Item Number on Yellow Card—page 19

For extreme operating conditions

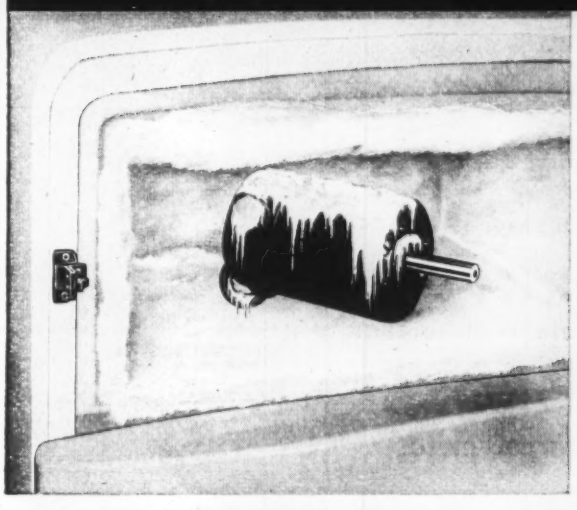
CHECK YOUR FRACTIONAL H. P. MOTOR APPLICATIONS WITH

HOWARD

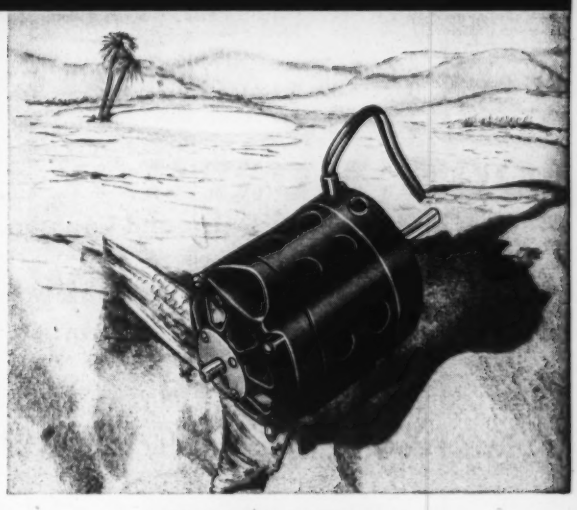


UNDER WATER

AT HIGH ALTITUDES



EXTREME COLD



EXTREME HEAT

Have a difficult fractional h.p. motor problem? Why not check with fractional h.p. motor specialists? Whether it be a problem of waterproofing, altitude, cold, heat, extreme quiet operation, long life or other exacting conditions, Howard has the motor to fill your need.

You'll find that Howard makes the most complete line of **fractional h.p. motors in the entire industry—Universal, Direct Current, Shaded Pole, Induction and Servo Motor types as well as gear motors and blowers in ratings from 1/2000 to 1/2 h.p.**

If you use fractional h.p. motors in your products, be sure to check with Howard. Write, wire or phone Racine 2-2731.

Make today your D day buy Owned States Defense Bonds

DEPT. MD-1 • HOWARD INDUSTRIES, INC. • RACINE, WIS.

SALES OFFICES: 208 S. La Salle St., Chicago 4 • 942 S. La Brea Ave., Los Angeles 36 • Room 4822, Empire State Bldg., New York 1

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION CYCLOHM MOTOR CORPORATION RACINE ELECTRIC PRODUCTS

—ITEM 199—

For More Information Circle Item Number on Yellow Card—page 19

NEW MORLIFE* CLUTCHES

*TRADEMARK

and

CLUTCH PLATES

Give—

100% MORE TORQUE GRIP

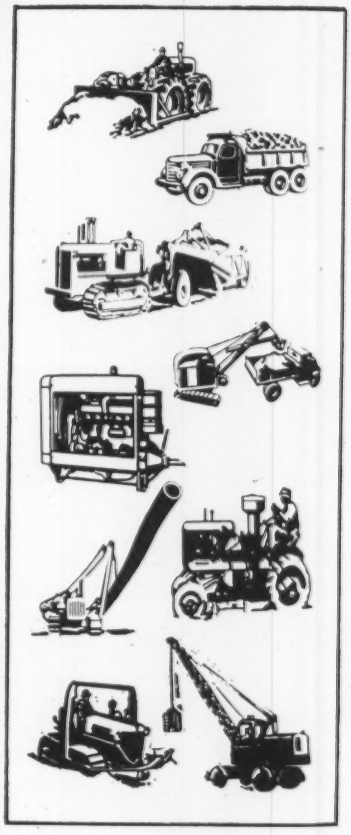
Reducing clutch size and engaging pressure

400% LONGER WORK LIFE

Operate longer without adjustment or plate replacement

50% BETTER HEAT DISPOSAL

Avoid down-time caused by burned or warped plates



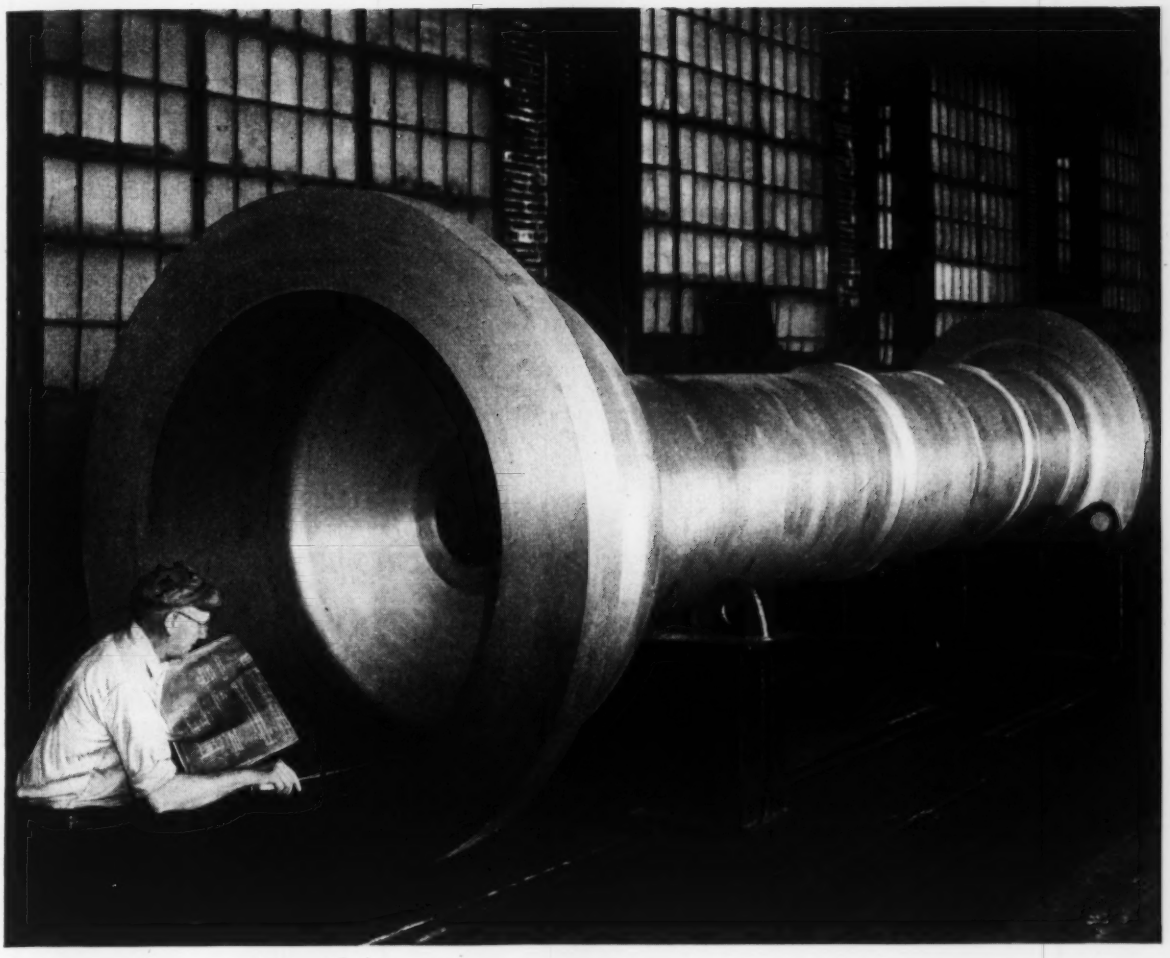
These NEW type ROCKFORD clutches have been developed and field tested by Rockford Engineers for heavy-duty clutch service. Because of their specialized characteristics, MORLIFE type ROCKFORD clutches are best suited for use in off-the-road machines such as tractors, trucks, tanks, cranes, shovels, bulldozers, earth movers, pipe layers, power units and other heavy duty equipment. For information how this NEW development will improve the operation and increase the on-the-job hours of your heavy-duty machines, write Department E.

B. W. ENGINEERING MAKES IT WORK
ENGINEERING
B-W
PRODUCTION
B. W. PRODUCTION MAKES IT AVAILABLE

ROCKFORD Clutch Division BORG-WARNER

311 Catherine Street, Rockford, Illinois, U.S.A.

—ITEM 200—



It would do credit to a sculptor

This beautifully symmetrical shaft is the product of expert steelmakers, forging men, and machinists, working as a team. Of carbon-vanadium steel, it has the contours of a delicate vase or a sculptured column.

But don't let appearances deceive you. Despite its stylish lines the shaft is intended for heavy-duty work in a hydroelectric plant. It weighs 39 tons, and the diameter of the large flange is 78 in. The main body has an OD of 35¼ in. The hollow part of the "bell"—the end nearest you—had to be machined out, leaving a cavity 54 in. in diameter x 34 in. deep. That took some doing.

In fact, the whole job took some doing. It required the most careful forging, treating, and machining—and before that, *planning*. It's the sort of thing that our engineers and shop men always look forward to.

We're showing it merely as a sample of what Bethlehem does in heavy forgings. But please don't get the impression that we only handle big jobs. If you require smaller pieces, we're all set up to make them for you. Even the smallest ones—tiny drop forgings that only weigh a pound or so.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

—ITEM 201—

NOW FOR DC OR RESISTANCE INPUT

MODEL 200-A uses an input of 10,000 ohm resistance potentiometers as an input transducer providing 10 to 1 scale expansion and origin positioning. Available standard digital input accessories are essentially inputs of this type. Any resistance potentiometer will provide an analog input for this configuration.

MODEL 200-B, used for D.C. signal input, has full scale sensitivities of 5 millivolts and an input impedance of 1,000 megohms. Utilizing standard reference cells, this model provides drift-free operation. Available external reference voltages may be substituted. A plug connection is provided to facilitate the quick interchangeability of input sections.

NOW FOR SIMPLIFIED OPERATION

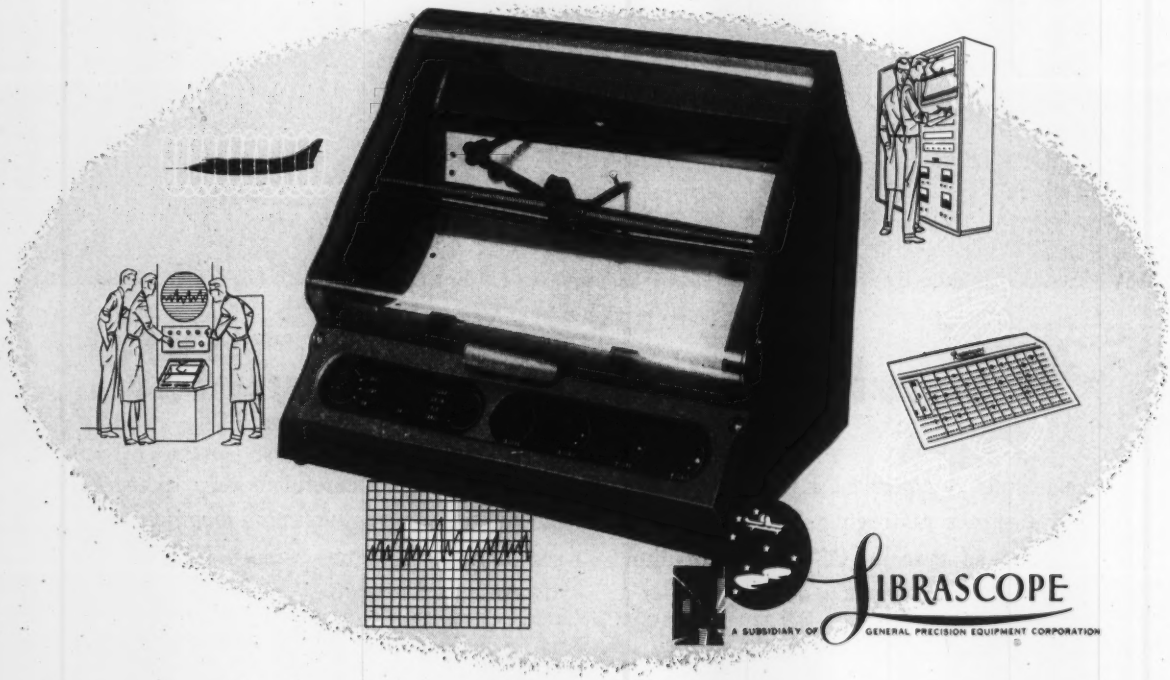
Precision Vernier Dials provide an accurate method for obtaining fine adjustment during operation. Optional point plot or continuous line plotting is a feature of both models. Selection is by front panel manual control. A new, simplified pen of one-piece design-used for point or continuous plotting—eliminates bottles and tubes, permits rapid changing of ink colors. Independent action of the X and Y axis is achieved with Librascope's unique "Floating Gear Train." No cables, tapes or lead screws to cause lost motion, cable stretching or drifting out of alignment. The 120° concave cylindrical plotting surface provides full visibility . . . is completely illuminated.

NOW FOR WIDER APPLICATION

These fast, dependable general purpose plotters feature 0.1% accuracy, are suited for wide applications where rapid graphic presentation of data is required, such as: laboratory testing, computers, data handling systems, wind tunnel, missile tracking and quality control testing of transistors and other electronic components. Input selection includes Punched Card and Tape Converters, Decimal Keyboards and Binary Converters. Model 200-A can plot from Flexowriter tape in any code or directly from the Tape Punch cables of many digital computers. Subchassis can be supplied to handle time-shared X versus Y plots, or other special circuitry. Write today for details.

LIBRASCOPE X-Y PLOTTER

HIGHEST ACCURACY FOR GRAPHIC DATA HANDLING



Greater input flexibility | For desk or rack mounting

NEW LIBRASCOPE PUNCHED TAPE CONVERTER
Operates from a punched tape reader—Specially designed for Librascope X-Y Plotters—
This unit is adaptable to other plotters.

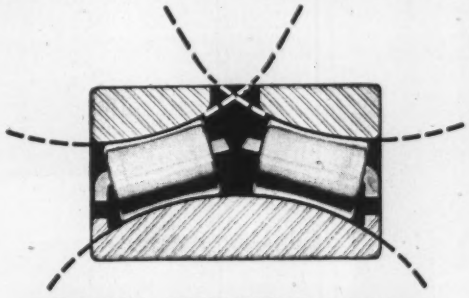
LIBRASCOPE X-Y DECIMAL KEYBOARD
Consists of three-decimal bank for each axis with associated plus minus keys. Features Librascope designed positive-action self-wiping contacts.

LIBRASCOPE PUNCHED CARD CONVERTER
Converts punched card data to analog form for input to X-Y Plotters. Automatic Position for feeding 50 punched cards per minute.

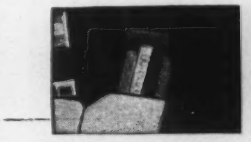
LIBRASCOPE INCORPORATED • 808 WESTERN AVENUE • GLENDALE, CALIFORNIA

—ITEM 202—
For More Information Circle Item Number on Yellow Card—page 19

These important
bearing differences
may spell longer machine life for you



FREE ROLLING—SELF-ALIGNING. Inner ring is truly spherical, free to align in any direction without affecting bearing capacity. Full load capacity is always assured despite shaft deflection or misalignment.

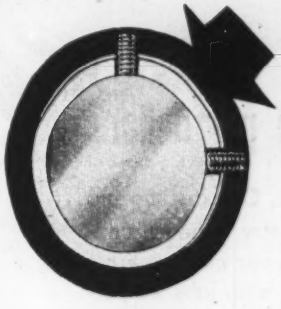


Contact Type Seals of felt laminated with synthetic rubber for extremely dirty conditions.

Labyrinth Seal for normal conditions.

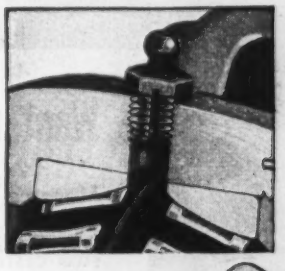
EFFECTIVE SEALING. Contact Type Seals of felt laminated with synthetic rubber or Labyrinth Seals (See above cut-aways) keep grease in and dirt out.

COLLAR SECURELY LOCKS INNER RING TO SHAFT. Tendency for collar to assume original circular shape reacts against the threads of the set-screws to maintain tightness. Use of set-screws in collar avoids distortion of inner ring.



Spring locking collar with two knurled cup-point setscrews secure bearing firmly to shaft.

EXCESSIVE GREASE PRESSURE PREVENTED. Lubrication fitting with pressure relief feature permits escape of excessive grease. Bearings are prelubricated and sealed at factory, ready for operation.



They're all present only in LINK-BELT roller bearings

BEARING inefficiency costs you more than replacement alone. The life of your machines is affected . . . capacity decreased . . . power wasted. That's why Link-Belt features unrestricted alignment of both ball and roller bearings. It compensates for shaft deflection or support distortion.

Every Link-Belt bearing offers advantageous *differences*—some big, some small, all important. Ask your Link-Belt office for Data Book 2550 covering this complete line of pillow blocks plus flange, flange-cartridge, cartridge, take-up and hanger blocks and self-aligning bearings.

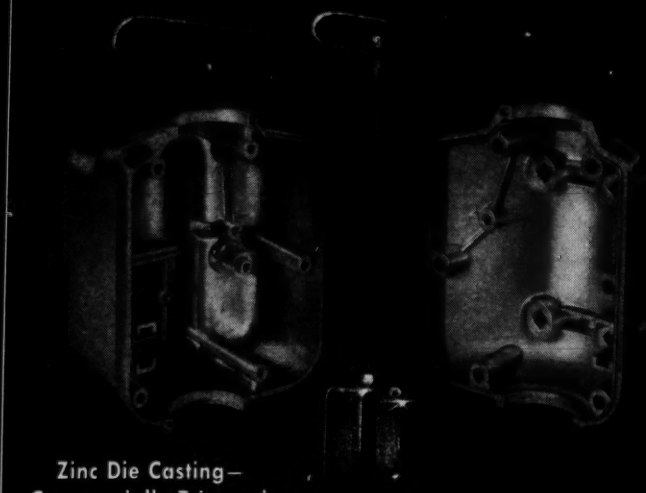
13.712R

Series 400 roller bearings are part of industry's most complete line of ball and roller bearing blocks.

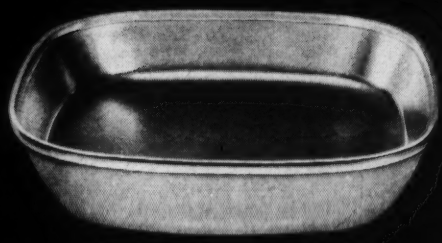
LINK-BELT

Ball and Roller Bearings

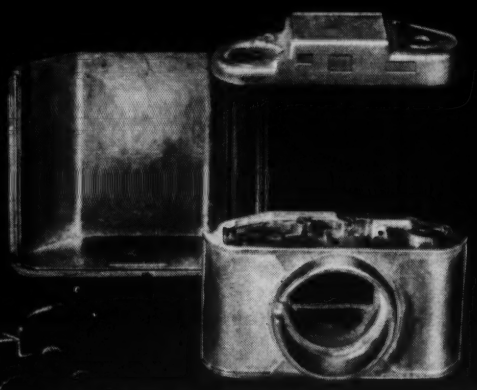
LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1.
To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.



Zinc Die Casting—
Commercially Trimmed



Aluminum Permanent Mold
Casting—Machined & Velvaglazed®



Aluminum Die Casting—
Commercially Trimmed

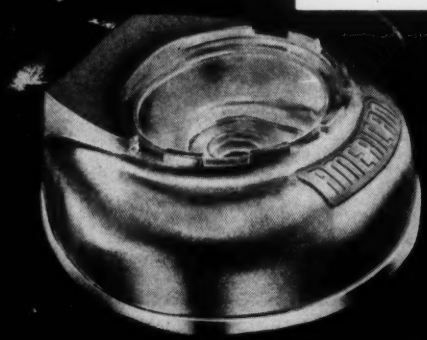
Want more casting value per dollar?

Monarch pioneers in casting progress. Our casting and finishing facilities, unique in the industry, produce unusual casting performance. The job your casting must perform is economically accomplished with jobs we perform on the casting.

Illustrated are a few major industries capitalizing on Monarch's ability to guarantee top-value castings at factual, low end-cost.

MONARCH ALUMINUM
PIONEERS IN CASTING PROGRESS

MONARCH ALUMINUM MFG. COMPANY
9205 Detroit Avenue, Cleveland 2, Ohio



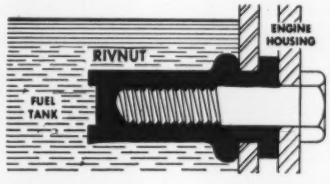
Aluminum Permanent Mold
Casting—Velvaglazed®

Aluminum Die Casting—
Commercially Trimmed

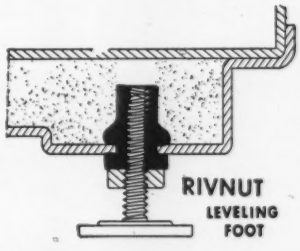
Aluminum Die Casting—
Commercially Trimmed

B.F. Goodrich Rivnut

solves practically any fastening problem

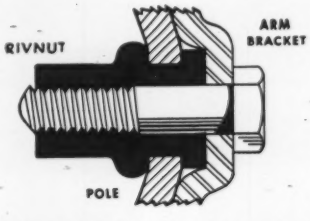


MAKES NUT PLATE, SEAL. Quickly installed in gas tank wall, Rivnut makes firm, accurate nut plate that can't be loosened by shock or vibration. At least six threads are clean for bolt attachment to engine housing. Straps, rivets, braces, nuts are eliminated. Rivnut's special closed end makes 100% gasoline-tight seal.

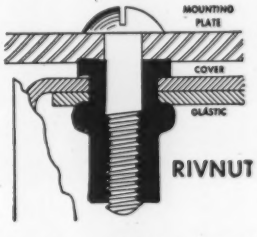


NEW WAY TO FASTEN LEVELING FEET. Appliance manufacturers install Rivnut in metal too thin to tap or weld *after* enameling. Bulge in Rivnut shank (second head) firmly grips the material. At least six threads remain clean to take the leveling foot screw—more than enough to handle the weight of heavy appliances.

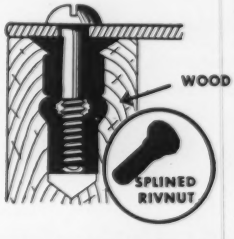
SPEEDS HANDLE ASSEMBLY. B. F. Goodrich Rivnut saves time fastening handle to small appliance. It provides a strong nut plate in *seconds*. Replaces slower fastening methods like nuts and bolts, welding, clinching, tapping. Rivnuts can be installed from one side and the open end types can take an attachment screw from either side.



CUTS ASSEMBLY COSTS 50%. In a street light application, it took two men to fasten the arm bracket to the pole. Then the manufacturer redesigned the unit to use Rivnuts. Now one man can do the job in the same time. Tests show the pole or arm bracket will fail before the Rivnuts.



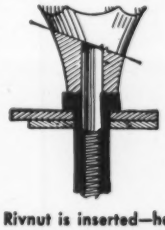
DOES TWO FASTENING JOBS. Rivnuts simplify transformer assembly from start to finish. Starting with unassembled parts, worker fastens sheet of plastic to metal cover with Rivnuts. With cover secured to frame, the Rivnuts then serve as mounting plate.



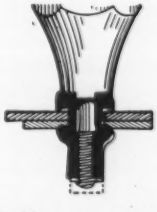
NEW WAY TO FASTEN TO WOOD. Special splined Rivnut for solid fastening in wood eliminates wood screws, provides six metal threads for attachment bolt. Bulge formed in shank holds Rivnut fast. Splined shaft keeps it from turning. Used for bus seats, metal backs in TV sets, etc.

How Rivnuts provide at least 6 clean threads in one simple operation!

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work—tool at right angles to work.



3 Tool lever-operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

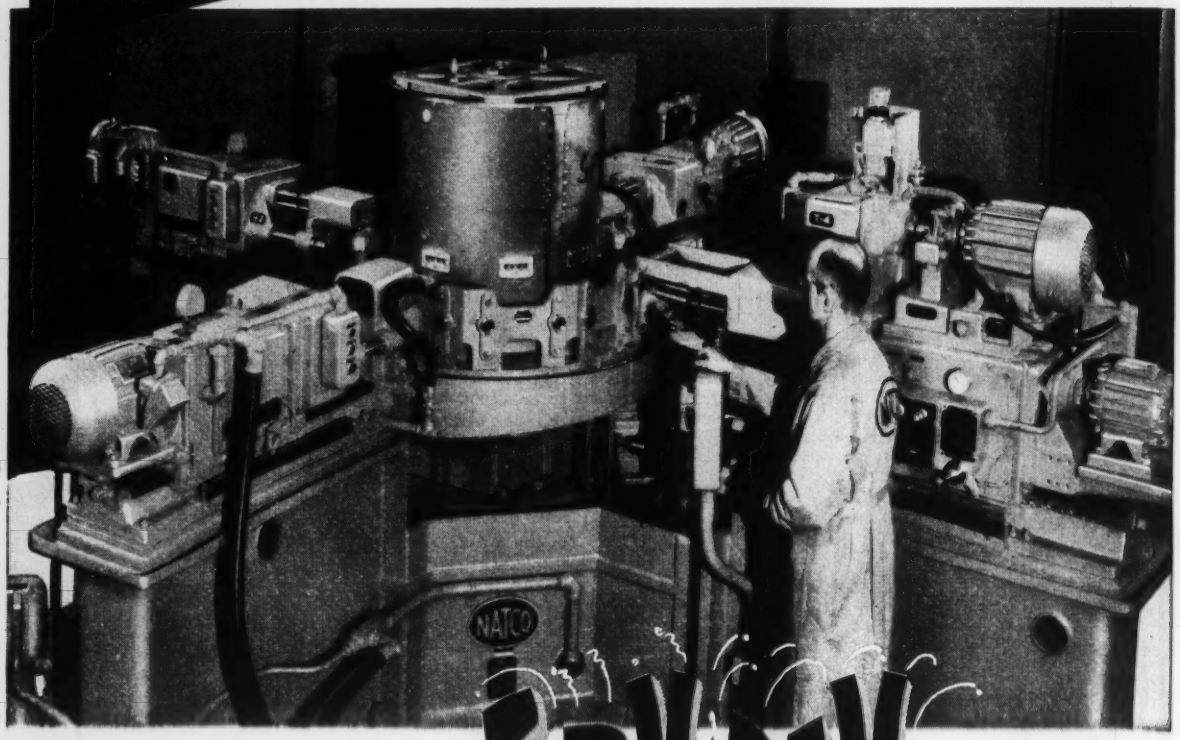
Demonstrates with motion how you can use Rivnuts to fasten TO and WITH. Explains construction, simplicity of installation. Get your free copy by writing to: The B. F. Goodrich Company, MD-16, Akron, Ohio.

B.F. Goodrich RIVNUTS

The only one-piece blind rivet with threads

—ITEM 205—

There's **MORE** Cooling Surface in these deep-ribbed **MOTORS**



No Day is FRYDAY

with these Allis-Chalmers MOTORS

● Frying of insulation is impossible under normal conditions with the extra-large cooling surface of Allis-Chalmers rib-type TEFC motors. The result—you expect and get longer motor life.

The engineered partner of A-C motors is Allis-Chalmers control.

Get Complete Information

As a new machinery component or as replacement, specify Allis-Chalmers. Discuss your particular application with your nearby A-C distributor, A-C district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-4881

—ITEM 206—

The Problem Jobs GO TO AETNA

SPECIAL PROPERTIES

- ✱ Stabilized ball races
- ✱ Stabilized, super-precision balls
- ✱ Matched assembly
- ✱ Magnaflux inspected
- ✱ Rust preventive finish

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Radial Ball Bearing Mounted Units • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Parts

HERE'S A BUSY BEARING purposely designed to wobble as it works—to eccentrically transmit pumping power to the pistons of one of aviation's foremost fuel injection pump and control assemblies. It's a hard working key component providing the unerring operational efficiency and dependability so vital to safety in the air.

To assure this reliability, every detail of this "wobble-plate" bearing must measure up to uncompromising specifications—in surface finish . . . in base flatness, parallelism and face angularity . . . in the hardness, stability and grain structure of its steel parts.

It takes something extra, something more than physical plant facilities to master today's special bearing problems and property requirements. That's why industry's leaders put more and more of their anti-friction problem-jobs up to Aetna. What interests them is not only Aetna's matchless experience, skill and special interest in such jobs, but also Aetna's proven ingenuity in innovating production and control methods to make them better, faster and at prices that are right.

Our staff of engineers, metallurgists and designers can help you too—from the inception of your ideas or problems to the final answers and applications of special ball bearings, roller bearings and miscellaneous bearing-type parts. A note from you will bring prompt action.

AETNA BALL AND ROLLER BEARING COMPANY

Division of Parkersburg-Aetna Corporation

4611 Schubert Avenue • Chicago 39, Illinois

—ITEM 207—

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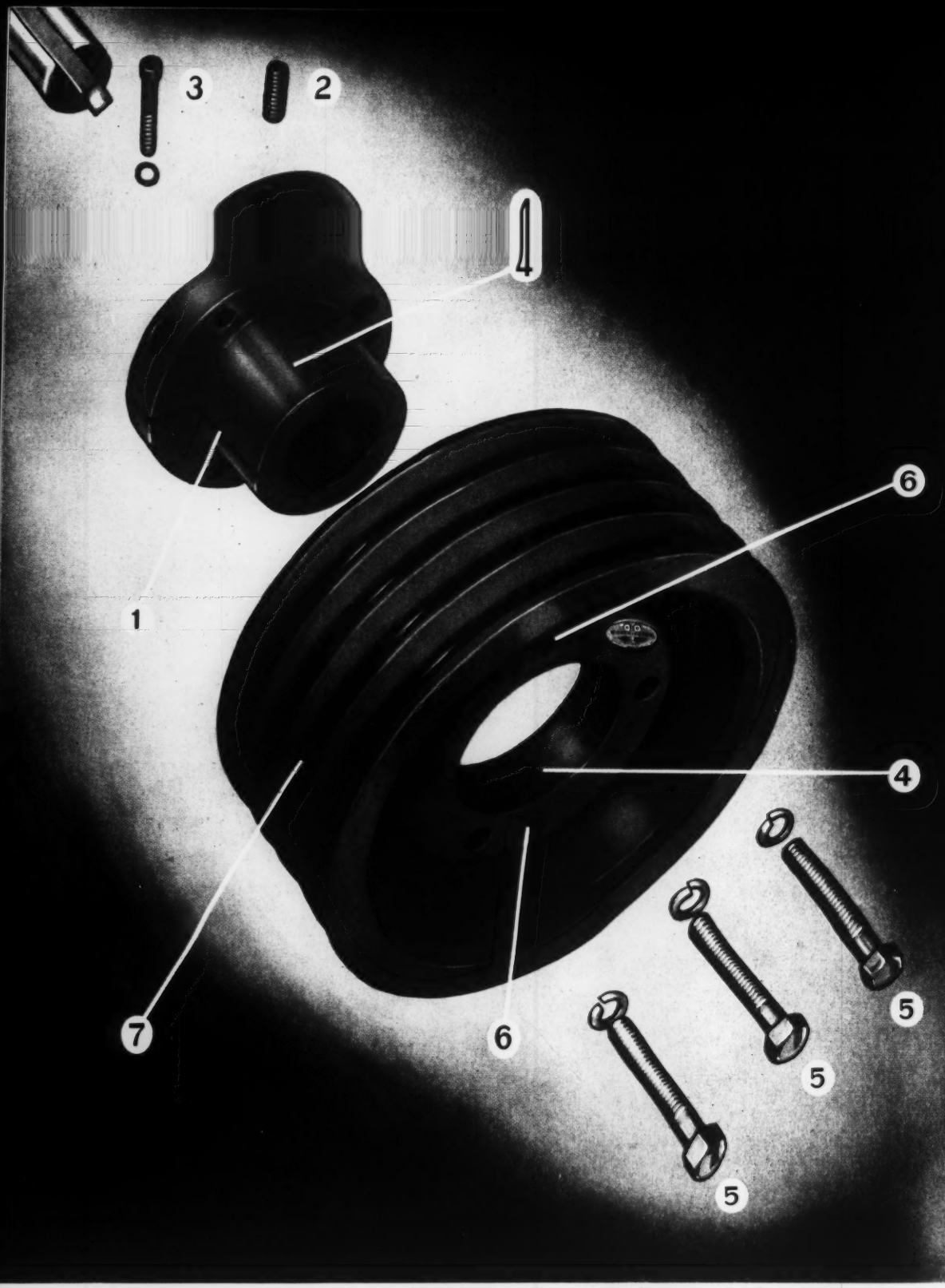


EXPLODED VIEW of Worthington QD Sheave shows design features that make it industry's first choice.

1. **COMPLETELY SPLIT QD HUB** holds shaft tightly under heaviest shock loads.
2. ***CUP POINT SET SCREW** in QD hub keeps shaft key in position.
3. ***CLAMP SCREW** secures hub in proper alignment on shaft when mounting sheaves.
4. **TAPERED FIT** between hub and sheave allows easy-on, easy-off, hold-tight action.
5. **PULL-UP BOLTS** draw sheave on to hub to produce positive fit on shaft.
6. **TAPPED HOLES** in sheave permit pull-up bolts to be used as jack screws to break cone grip when removing sheave.
7. **GROOVE CROSS-SECTIONS** are accurate and uniform so that each V-belt seats properly, pulls evenly.

***All Worthington-Manufactured QD Heavy-Duty Hubs incorporate these exclusive features.**

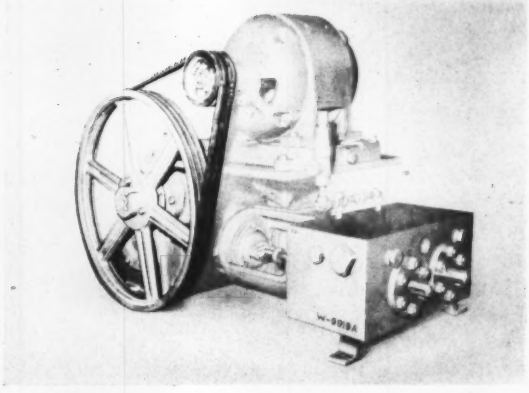
Who says all sheaves are alike?

Nobody who ever saw the Worthington QD, we wager.

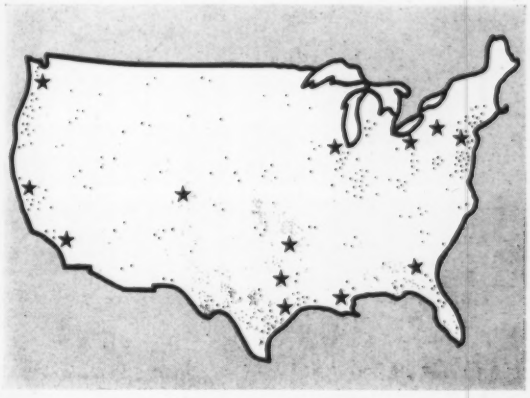
Big difference between the QD (that's short for quick-detachable) and ordinary sheaves is this: the QD is easiest to get on, easiest to get off, yet always grips tightly on the shaft.

Those are the big reasons why design engineers specify more QD's than any other sheave — why the QD will do a *better* job on *your* product.

More reasons for standardizing on the QD



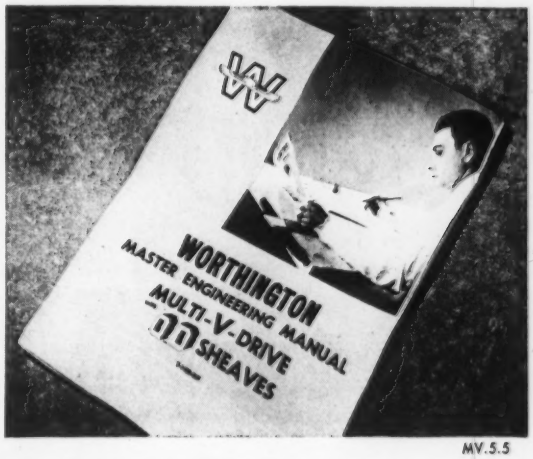
SCIENTIFIC DESIGN of Worthington QD Sheaves not only provides more efficient transmission of power but actually adds to the looks of your product. What's more, I-beam construction of the QD DriveN sheave provides greater strength with less weight. You'll find Worthington QD Sheaves a dependable source of trouble-free mechanical power transmission. The large variety of immediately available standard sizes and ratings, for A, B, C, and D section V-belts, makes for a simple, economical solution to your design problem.



PROMPT SHIPPING SERVICE. Thirteen factory warehouses with stocks covering over 100,000 V-belt drive combinations, from ½ to 600 horsepower, support more than 250 distributor outlets. These shipping centers can fill your requirements *fast*.

Warehouses Located at: Kearny, N. J. • Oil City, Pa. • Portland • San Francisco • Los Angeles • Denver • Tulsa • Ft. Worth • Houston • New Orleans • Chicago • Cleveland • Atlanta, Ga.

GOOD NEWS FOR DESIGN ENGINEERS! Now, with Worthington's new 100-page "Master Engineering Manual," you can select the right sheave and V-belt combination for your equipment in *three minutes*. Easy-to-use tables take all the complications out of sheave selection — require only simple arithmetic. Be sure to write for your copy today. It's free, of course. Worthington Corporation, Mechanical Power Transmission Division, Section MV.5.5, Oil City, Pa.

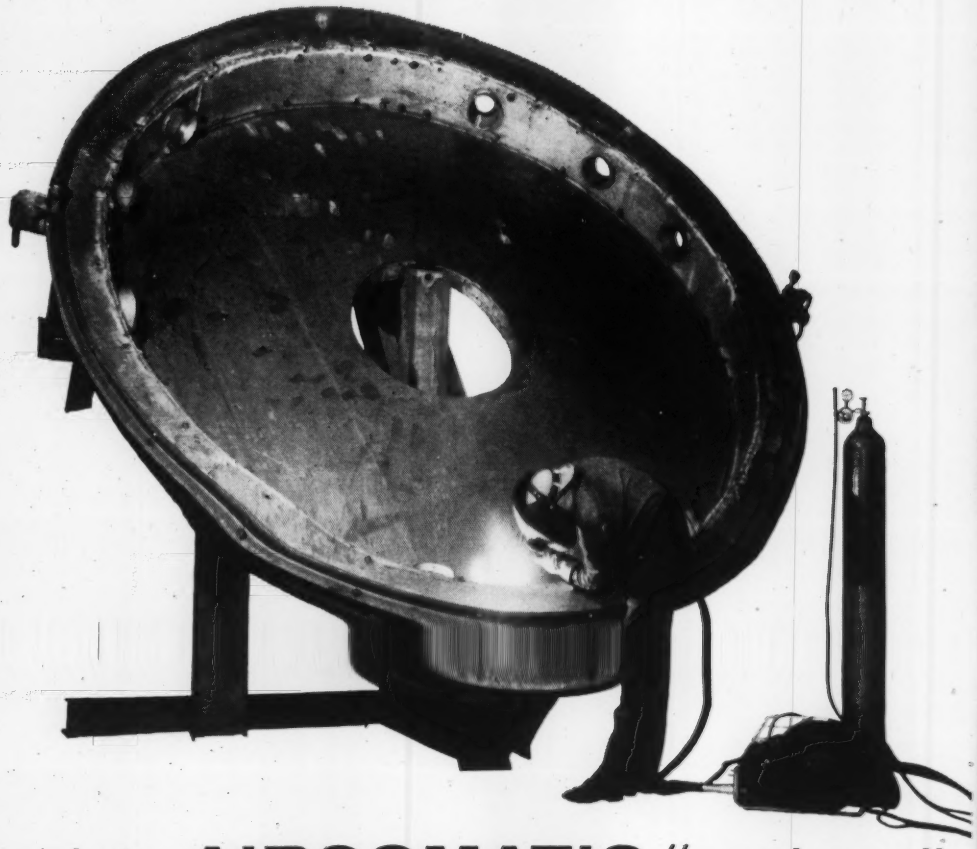


MV.5.5

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

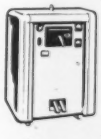


a complete **AIRCOMATIC** "package" . . . from recommendation to results

Aircomatic welding is an inert-gas, shielded arc process using a a consumable wire electrode. The basic unit, manual or automatic, designed and manufactured by Airco, includes the welding head, carriage assembly for wire drive and control equipment, cables, hoses, and flexible wire casing.

The consumable wire electrode is produced to rigid Airco specifications as to purity, cast, and metallurgical content. Normally supplied on expendable spools, Aircomatic wire is available in aluminum, steel, stainless steel, nickel, titanium, copper, and copper base alloys.

Airco shielding gases include both helium and argon, produced by Airco, or mixtures thereof for particular requirements. Pure carbon dioxide gas is also available from Airco for use as a shielding medium where applicable.



Aircomatic is a direct-current welding process. A complete line of Airco motor-generator and rectifier type welders are designed for Aircomatic characteristics – the latest of which is a new 800 amp CAV welder.

The Aircomatic process was invented, designed, developed, and licensed by Airco. Airco's eight years of experience have given the metal working industry an inert-gas process that welds all kinds of metals – adding speed, economy and versatility to every suitable application.

An Airco Representative can give you a completely unbiased opinion as to how Aircomatic can best be employed—because—Airco is a leading manufacturer-supplier of all types of oxyacetylene, metallic arc and inert-gas shielded welding and flame cutting processes, their controls, supplies, and accessories.

Other Airco inert-gas welding processes include Aircospot and Heliwelding. Write today for details.

AT THE FRONTIERS OF welding PROGRESS YOU'LL FIND . . .

AIR REDUCTION PRODUCT

AIRCO®

Offices and dealers in most principal cities

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated, New York 17, N. Y.

On the west coast – Air Reduction Pacific Company

Internationally – Airco Company International

In Cuba – Cuban Air Products Corporation

In Canada – Air Reduction Canada Limited

Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** – industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** – carbon dioxide, liquid-solid ("DRY-ICE") • **OHIO** – medical gases and hospital equipment • **NATIONAL CARBIDE** – pipeline acetylene and calcium carbide • **COLTON** – polyvinyl acetates, alcohols, and other synthetic resins.

—ITEM 209—

WELDING SOLVES ANOTHER WEIGHT PROBLEM

(and USS "T-1" Steel solves the welding problem!)

Bedplates for modern color-printing presses have to be rugged—but as lightweight as possible. They must withstand constant pounding from printing rollers and cutting knives. And, since they move back and forth continually, they've got to be lightweight for fast, efficient operation. It is a good place to use a welded assembly of steel plate.

But that's where Graver Tank & Manufacturing Co., Inc., ran head-on into a tough fabrication problem. Alloy steel with the necessary strength and durability was difficult to weld. And with 534 welds to make on *every* bedplate, this was a king-size headache.

NO MORE HEADACHE!

Now the headache is gone. Production costs are down. And the finished bedplates are working hard and long . . . taking a tremendous daily pounding without distortion.

The solution? Just a switch to a remarkable *new* alloy steel, USS "T-1" Steel.

"'T-1' Steel is very strong. Very tough. Able to take vicious impact abuse. Yet, it's easy to weld," says Mr. H. McDonald, Superintendent at Graver.

HOW ABOUT YOU?

If you have tough jobs, rugged jobs, where you want to weld your way to lower costs, give this new steel a try. We think you, like Mr. McDonald, will find it the best thing you have ever used. Right now, "T-1" is in service and doing well in bridges, power shovels, steam turbines, electrical transformer tanks, flywheels, pressure vessels, mine cars, and lots of other places. Write for details. United States Steel, Room 5082, Pittsburgh 30, Pa.

"TOP QUALITY" That's how Graver Tank & Manufacturing Co., Inc., East Chicago, Indiana, describes new USS "T-1" Steel. It gives them a yield strength of 90,000 psi . . . exceptional resistance to impact abuse . . . and good weldability. It enables them to build extremely rugged, all-welded bedplates for printing presses.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T1" CONSTRUCTIONAL ALLOY STEEL

USS

6-15

UNITED STATES STEEL

Another new development using

B. F. Goodrich Chemical *raw materials*

Pipe Dreams come true with Geon Rigid Vinyl!

IF you've dreamed of cutting piping costs in half, listen to this: On a major piping installation, General Electric Appliance Park changed earlier planning and used pipe made from Geon rigid vinyl...results show a fine job at much lower cost.

This corrosion resistant Geon pipe carries deionized water at 300 psi in lines ¾″ to 2″. Fittings are made from Geon, too, by a new injection molding process that provides appreciably greater strength and dimensional accuracy.

Geon rigid vinyl piping costs much less, and in many cases proves more serviceable than high grade steel and alloys. It is light in weight, saves money in installation and changeovers. It resists acids, alkalis, oil and gas . . . has exceptionally high impact strength.

Geon polyvinyl materials make possible many economies and improvements, point the way to increased sales and profits. Geon materials are available in many forms for use in many products—upholstery, flooring, sponge, wire and cable insulation, and a host of others. To find how Geon can fit into your future, please write Dept. DO-1, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.

GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

What's your shape?

J&L's EXTRUDED SECTIONS

(Hot Extruded and Cold Drawn)

can be custom-made quickly and economically

Now your complex sections can be *custom-made* at J&L's new Hot Extrusion Plant. On J&L's new equipment, they can be preformed to the predominating cross section of the part you wish to produce.

The range of sections that can be custom-made for you is almost unlimited. Quantities are extremely flexible. Production of single extrusions, where necessary, can be arranged.

In addition, J&L's Extruded Sections possess the physical benefits and accurate tolerances derived from cold drawing. And, you can obtain them in a wide range of analyses.

Send your inquiry today!

J&L EXTRUDED SECTIONS
elp speed production
educe over-all costs

J&L STEEL

Jones & Laughlin
STEEL CORPORATION – *Pittsburgh*

With J&L's Extruded Sections you can:

1. Eliminate time and costs in machining operations.
2. Eliminate time and costs in finishing operations.
3. Reduce scrap losses practically to the zero point.
4. Eliminate the cost of castings and forgings of intricate sections requiring considerable machining.

USE THIS HANDY COUPON

Jones & Laughlin Steel Corporation
3 Gateway Center, Dept. 410, Pittsburgh 30, Pa.

I am interested in knowing what your Extruded Sections can do for me.

NAME_____

TITLE_____

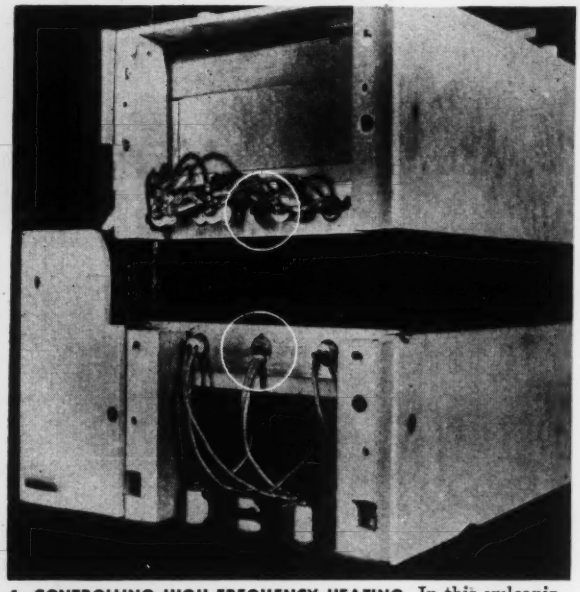
COMPANY_____

STREET_____

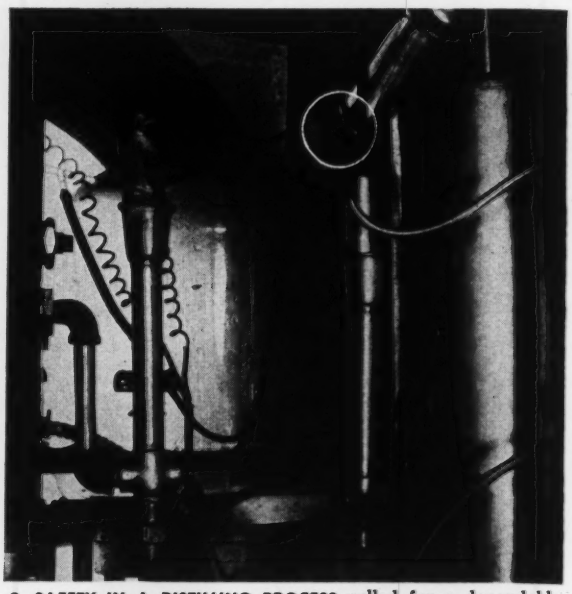
CITY_____ ZONE_____ STATE_____

XUM

How would you solve these tricky temperature control problems?

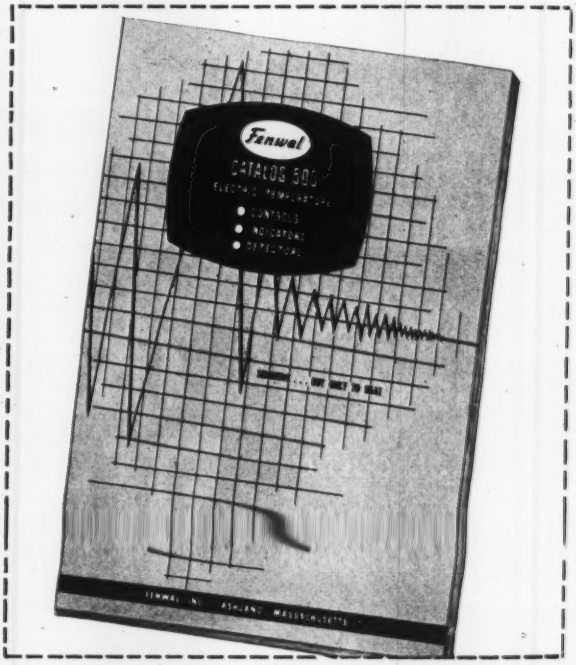


1. CONTROLLING HIGH FREQUENCY HEATING. In this vulcanizing patch press, precise temperature control of the platens was required to prevent loss of electronic heat generated within the processed material. Fenwal's solution was two THERMOSWITCH® units, set at 400F, mounted on the platens. Result: a production rate of 3,000 patches per hour, compared to ordinary hot press methods of 30 per hour.



2. SAFETY IN A DISTILLING PROCESS called for a dependable failure alarm. A Fenwal THERMOSWITCH unit in the condenser's safety vent solved the problem. Now, should the cold water supply fail, steam blowing through the condenser tubes will hit the THERMOSWITCH unit. This control, set at 120F, will then open, shutting off the electric heaters and sounding a continuous alarm.

3. PROTECTING PRODUCTS. In this shoe lining smoother, the problem was twofold: to use the fewest possible thermostats; provide close temperature control in order to prevent burning of shoe leather. Fenwal's solution: a single adjustable THERMOSWITCH unit, mounted on one ironer and controlling two ironers. This halved the number of thermostats indicated, while providing precision temperature control.



4. SEND FOR NEW CATALOG, just off the press. It describes Fenwal's complete line of THERMOSWITCH units and new indicating controllers for industrial applications. Fenwal engineers are always glad to help on any of your temperature control problems. Write **Fenwal Incorporated, 191 Pleasant St., Ashland, Massachusetts.**

Fenwal THERMOSWITCH®

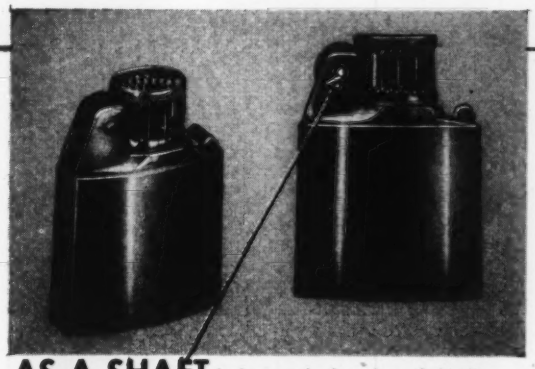
Controls Temperature — Precisely

—ITEM 213—

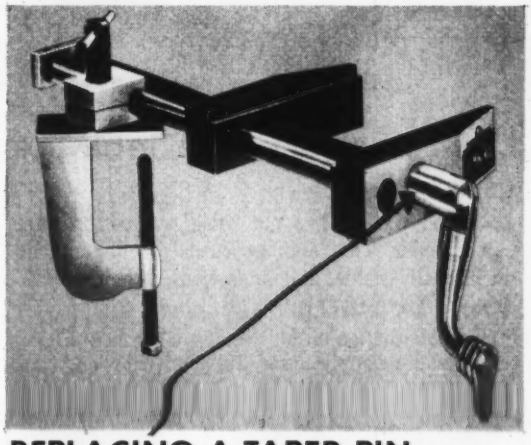
For More Information Circle Item Number on Yellow Card—page 19

Three typical Rollpin cost reductions

AS A RIVET Rollpin cuts material and assembly costs 25% on Reynolds Gas Regulator Co.'s toggle lever assembly.



AS A SHAFT before and after shot of this Ronson lighter shows how Rollpin made savings of 1½¢ per unit in assembly of spark wheel.



REPLACING A TAPER PIN Rollpin saves 24¢ labor cost on each of American Machine and Foundry's MITY-7-VISES. Eliminates tool cost caused by breakage of small taper reamers.

ESNA® TRADE MARK

ROLLPIN TRADEMARK

Where can you use this simple fastener?

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your production and maintenance costs as it does in every class of industry. Rollpin is a slotted tubular steel pin with chamfered ends that drives easily into standard holes, compressing as driven. Its spring action locks it in place—withstanding impact loading, stress reversals and severe vibration. No threading, peening or precision drilling needed. Rollpin is readily removable and can be re-used in the same hole.

ELASTIC STOP NUT CORPORATION OF AMERICA

MAIL COUPON FOR DESIGN INFORMATION

Elastic Stop Nut Corporation of America
Dept. R38-14, 2330 Vauxhall Road, Union, N. J.

Please send the following fastener information:

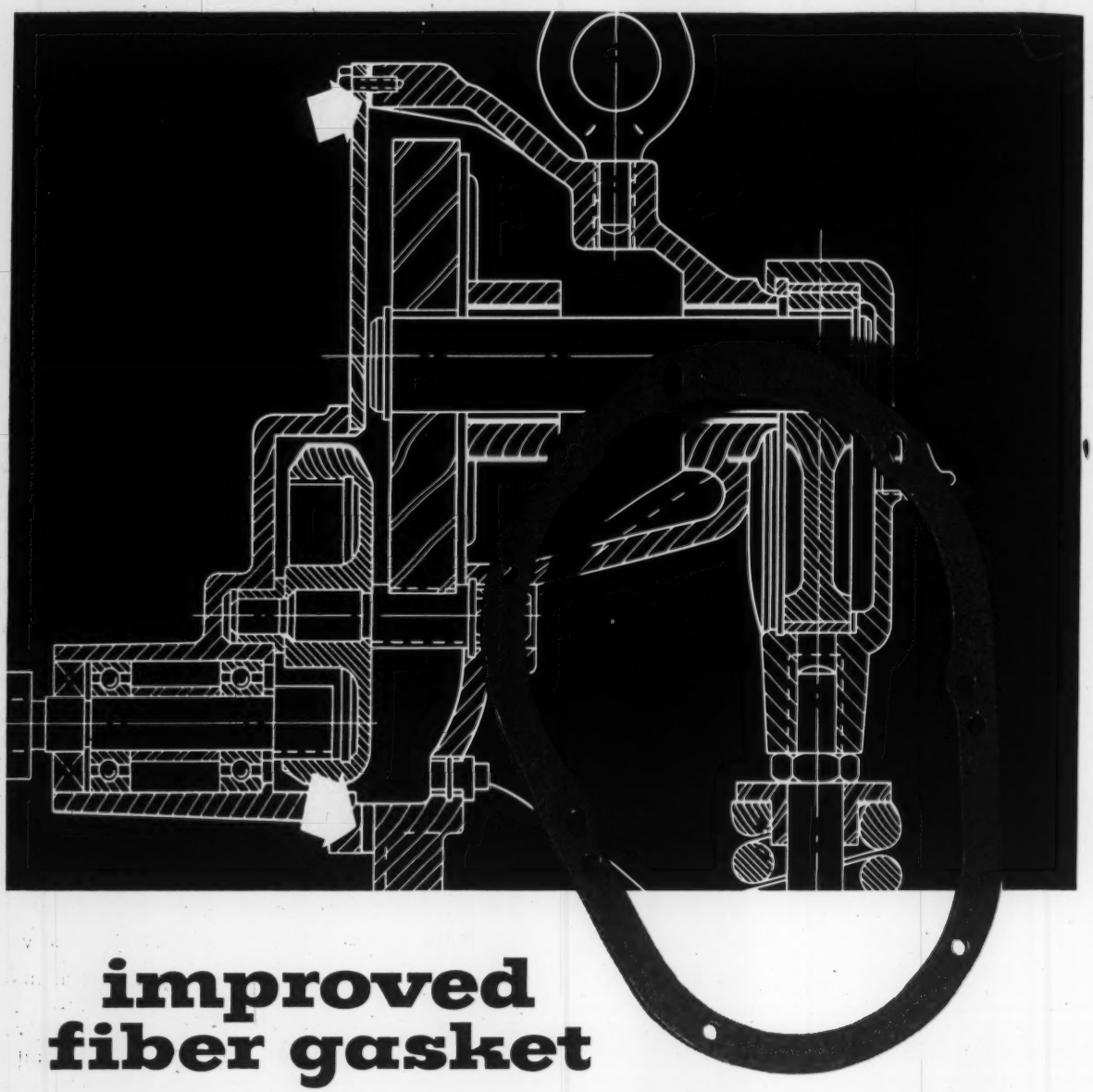
☐ Rollpin samples
☐ Rollpin bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____ Zone___ State_____

—ITEM 214—



improved fiber gasket

withstands concentrated load, stops gear-case leakage

After a short time in the field, the self-priming diaphragm pumps made by a mid-western manufacturer started losing oil. The trouble was traced to the gear-case housing gaskets, which were being squeezed out of joints because narrow flanges concentrated the bolt pressure.

The oil leaks stopped, however, when Armstrong CN-705 Accopac® was used in place of the original gasket material. Because Accopac is unusually compressible and crush resistant, it maintained a perfect seal on the narrow flange. This compressibility also means that Accopac conforms to the normal irregularities in stamped flanges—as well as to those found in rough-milled flange surfaces.

Accopac won't shrink or dry out, either. It's made by a patented beater-saturation process which blends fiber and cork with a non-volatile, non-extractable latex binder. The resultant sheets are uniform, dimensionally stable, and impervious at bolting pressures as low as 800 psi.

For information on how Accopac can help in specific gasketing applications, call your Armstrong man.

FREE 24-PAGE GASKET MANUAL—Look for "Armstrong Gasket Materials" in Sweet's product design file . . . or write for your own copy to Armstrong Cork Company, Industrial Division, 7001 Dean St., Lancaster, Pennsylvania. **And be sure to specify Armstrong Gasket Materials when you order from your gasket cutter.**

Armstrong Accopac

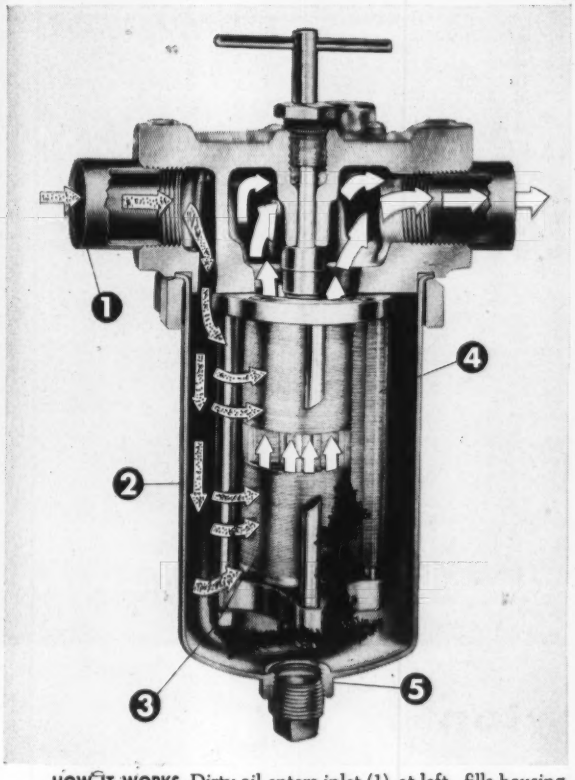
. . . used wherever performance counts

—ITEM 215—

For More Information Circle Item Number on Yellow Card—page 19

NOW! 40-micron, self-cleaning filter

It's the new Cuno SUPER Auto-Klean



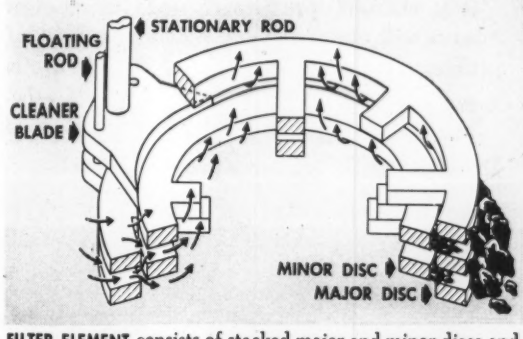
HOW IT WORKS. Dirty oil enters inlet (1) at left, fills housing (2) and flows through metal edge-type filter (3). Clean oil rises through center of filter, leaves at right. Dirt combed out by cleaner blades (4) is removed through drain (5).

Cuno's new SUPER Auto-Klean is the first practical, compact micronic filter for lubricating oil, hydraulic fluid, coolant, fuel, and other industrial fluids.

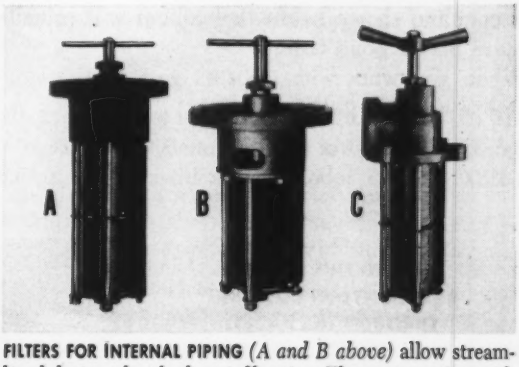
Many times smaller than other micronic filters of equal capacity, Cuno's new SUPER Auto-Klean filter now makes possible economical, micronic filtration at high flow rates and eliminates the need for replacement cartridges in most cases. Here's what it offers:

1. **Full-flow** 40-micron filtration with a self-cleaning filter. Positive protection against particles larger than 40 microns (actually 0.0015 in.). All-metal filter can't rupture or channel.
2. **Easy cleaning.** Just turn the handle—by hand or continuously with motor drive. No interruptions for cleaning.
3. **No cartridge changes.** Ends operating costs if you've been using cartridge filters.
4. **Low pressure drop, no pressure drop build-up.** An 8" by 2¼" SUPER Auto-Klean filters 30 gpm of 200 SSU oil with only 3 psi pressure drop—up to 75% more with slightly higher pressure.
5. **High capacity in a small package.** Many times smaller than replaceable-cartridge type filters of equal capacity, it saves with lower initial costs, lower installation costs.
6. **Easy to build into new equipment.** Available for line-type housings *(left)* or incorporation in sump or reservoir *(below.)* Works in any position.
7. **Easy to install in old equipment.** Fits existing Auto-Klean housings. You can easily replace most 2¼" diameter elements with SUPER Auto-Klean for finer filtration.

Write today for complete technical data on the new SUPER Auto-Klean for your new or existing equipment. Ask for Catalog No. SAK-057. Cuno Engineering Corporation, 14-1 South Vine Street, Meriden, Connecticut. 5.9



FILTER ELEMENT consists of stacked major and minor discs and cleaner blade bearing against minor discs. Small arrows show flow. Short restrictions between minor and major discs stop 40-micron particles but allow high flow rate.



FILTERS FOR INTERNAL PIPING *(A and B above)* allow streamlined design plus the best infiltration. Flange mounting with external outlet *(C above)* and line-type *(large cutaway above left)* are just a few of many other possibilities.

CUNO **ENGINEERED FILTRATION**

Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (edge-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound) • PORO-KLEAN (porous metal)

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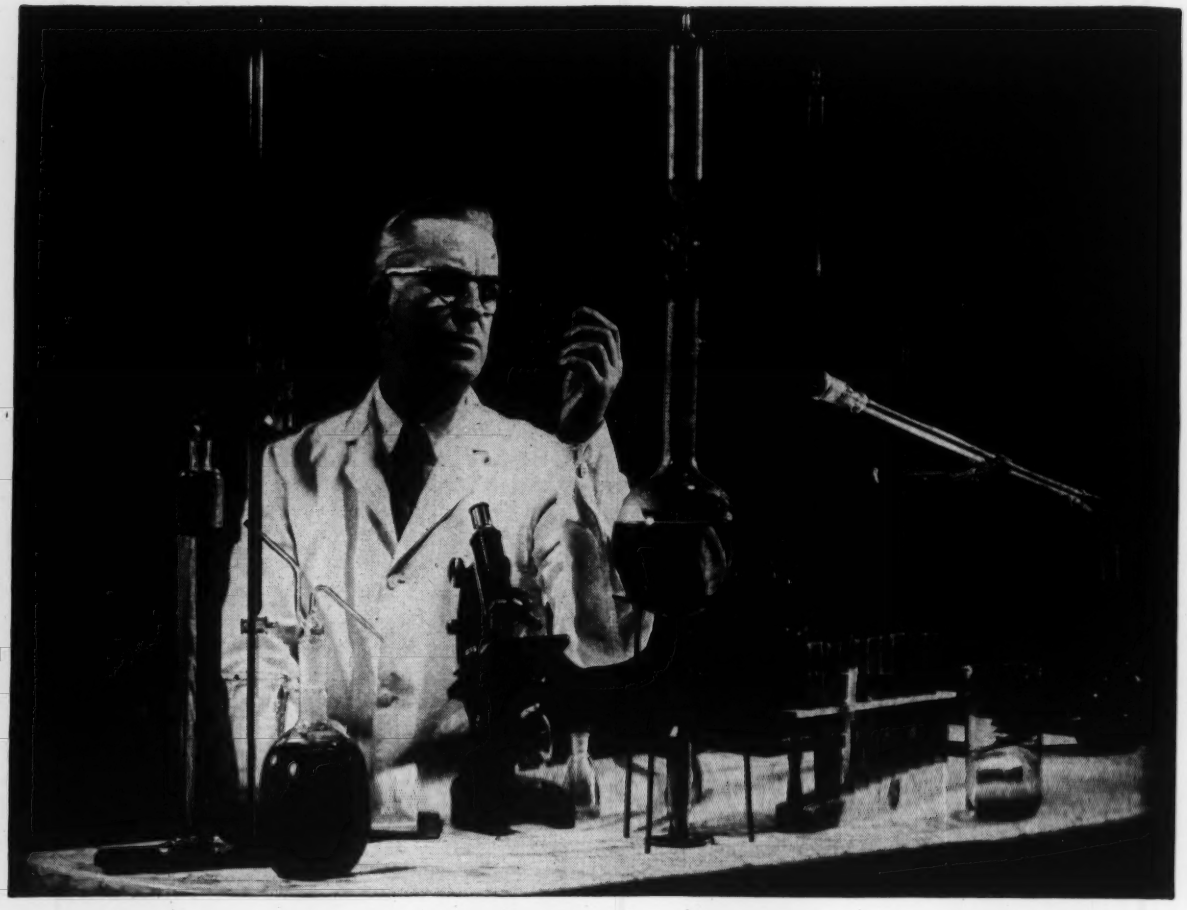


Bonding rubber to nylon is one of PHOENIX' specialties

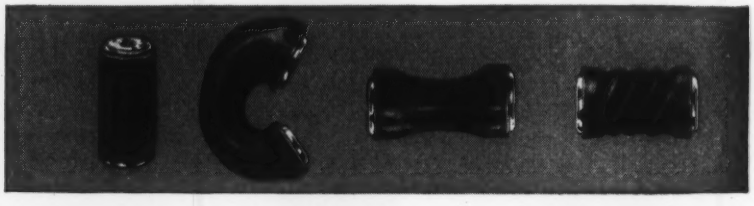
We are unusually successful at bonding natural and synthetic rubber to nylon. For example, with the flexible coupling shown below, the rubber will actually rupture before bond failure.

When you work with PHOENIX you have twenty years' experience in developmental work at your disposal. Quality control is of the utmost importance at PHOENIX. Modern laboratory facilities and exacting production control methods assure the closest of tolerances.

It is PHOENIX' practice to work in strictest confidence with our customers. Whatever rubber molding problems you may have, call on us. We are here to serve you.

Please address all inquiries to Rubber Products Division.

PUTTING THIS FLEXIBLE RUBBER-NYLON COUPLING THROUGH THE PACES. TESTING ITS "BEND," TENSILE STRENGTH AND TORQUE.



PHOENIX should be your source for custom rubber molding

PHOENIX MANUFACTURING COMPANY

RUBBER PRODUCTS DIVISION — JOLIET, ILLINOIS

—ITEM 217—

For More Information Circle Item Number on Yellow Card—page 19

the POWER you need in ⅓ less space . . .

O-M CYLINDERS
TIE ROD-LESS

- *air and hydraulic*
- *meet JIC standards*

O-M's special interlocking mechanism strips unnecessary bulk, does away with tie rods and out-sized end caps . . . saves up to ⅓ the installation space required by conventional-type cylinders of the same bore.

This internal locking feature means less maintenance, too, O-M cylinders are easier to clean, inspect, remove, disassemble and service, with no alignment problems in re-assembly.

Available in complete range of sizes (1½ to 8" bores), with standard, 2 to 1 or oversize rods. All steel construction with bearing bronze. Completely interchangeable parts. Immediate delivery on many sizes.

mail coupon now!

for FREE catalog, showing all cylinders, mounts and mounting brackets.

ORTMAN-MILLER MACHINE COMPANY
7 143rd Street, Hammond, Indiana

☐ Have representative call ☐ Send latest catalog

Name_____ Position_____

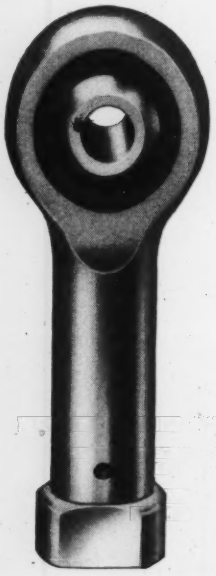
Company_____

Address_____

City_____ Zone____ State_____

—ITEM 218—

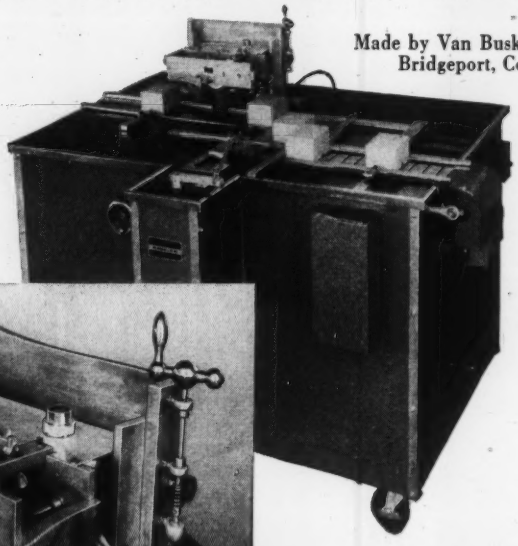
We use 23 HEIM *Unibal* ROD ENDS on each machine

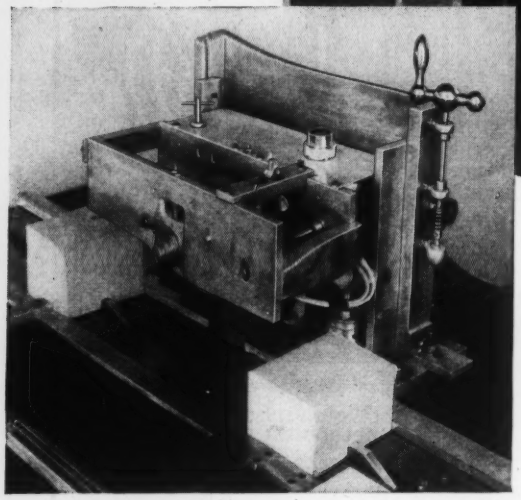


"Because they cost less than specially machined parts, give us smoother action, and take less time to assemble."

The Van Buskirk marking machine imprints metal cans, folding or set-up boxes, and corrugated cartons, on 1, 2, 3, 4 or 5 sides in one pass, after they have been packed. The imprinting is in perfect register, in any color of ink or style of type, at speeds in excess of 100 per minute. This portable machine can be moved to its proper place at the end of an assembly line for automatic feeding. It eliminates the necessity of carrying a large inventory of specially printed boxes or labels.

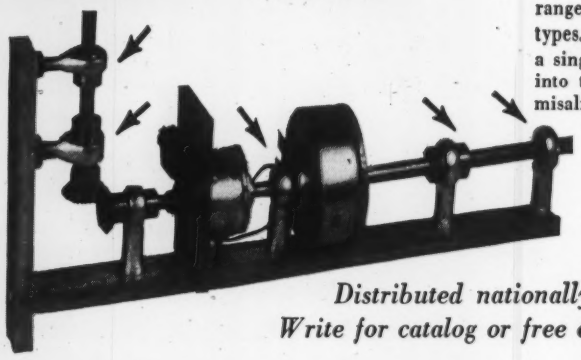
Made by Van Buskirk & Co., Inc.
Bridgeport, Connecticut





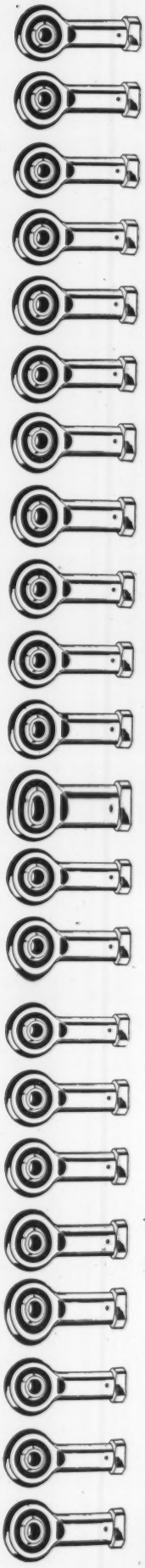
Heim Unibal Rod Ends are used on this machine not only as rod ends in the linkages, but as self-aligning supports for the split shafts in the clutch assembly and the worm gear shaft for raising and lowering the printing drums.

The Heim Unibal is made in a wide range of sizes in both male and female types. They can be installed by drilling a single hole and fastening with a bolt into the female rod end. They correct misalignment in every direction.

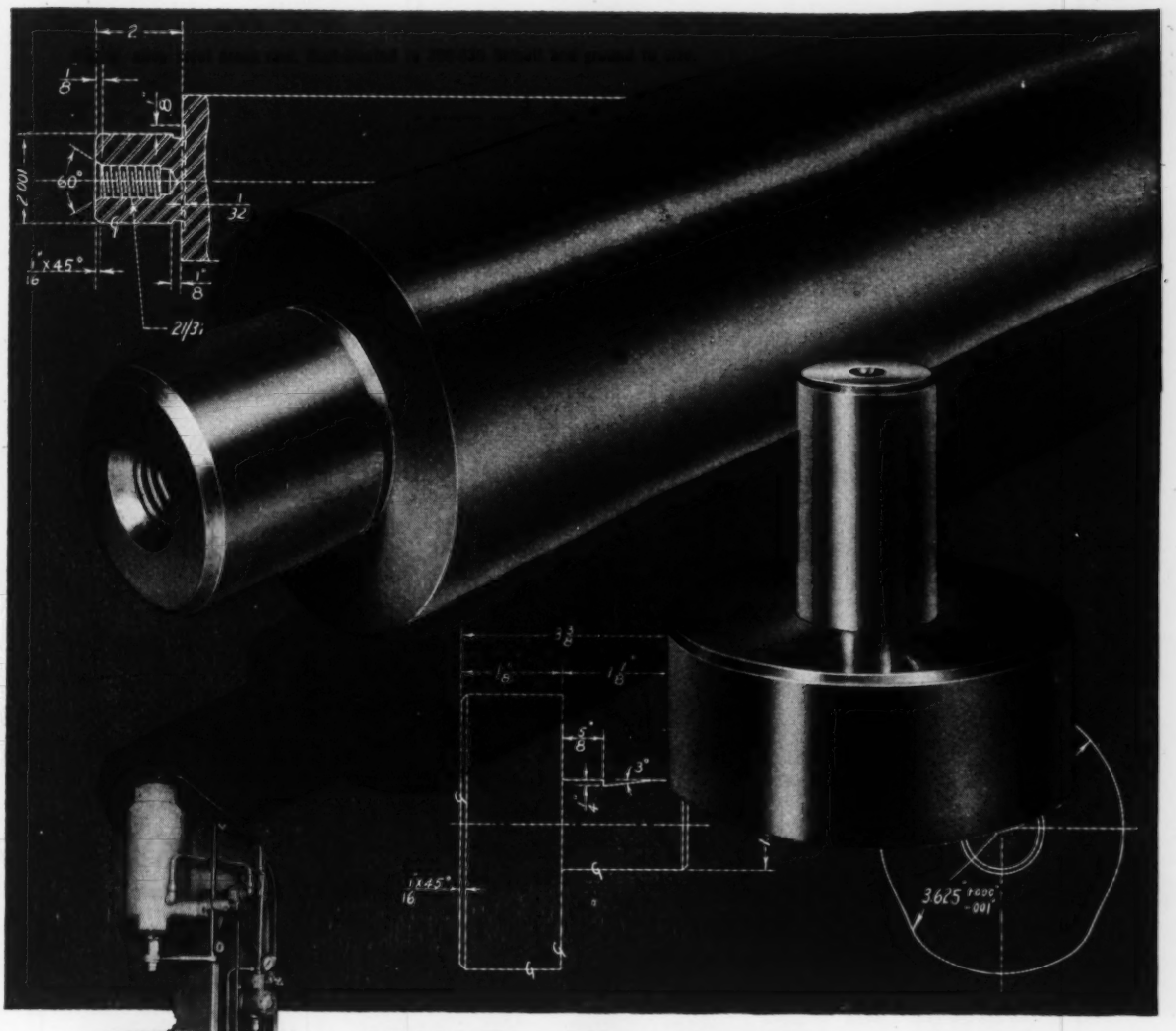


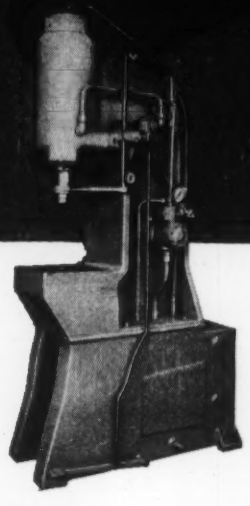
Distributed nationally by bearing specialists.
Write for catalog or free engineering information.

THE HEIM COMPANY FAIRFIELD CONNECTICUT



—ITEM 219—
For More Information Circle Item Number on Yellow Card—page 19





MAX-EL Alloy Steel means no distortion—longer wear in 15-ton hydraulic press ram

To keep this 15-ton press operating day after day for years of dependable service, takes *special* steels. For example, even after thousands of cycles of operation, the ram *must* remain accurately in line with the work table. *It demands a steel that will not distort, set or wear.*

That's why both the ram and ram-plug are made of Crucible MAX-EL alloy steel. In fact, the manufacturer, Greenerd Arbor Press Co., Nashua, N. H., has been a steady user of MAX-EL for many years.

Here's what they have to say—*"We have tried many grades of steel, but we find that MAX-EL 3½ heat-treated in the bar works out better for our application."*

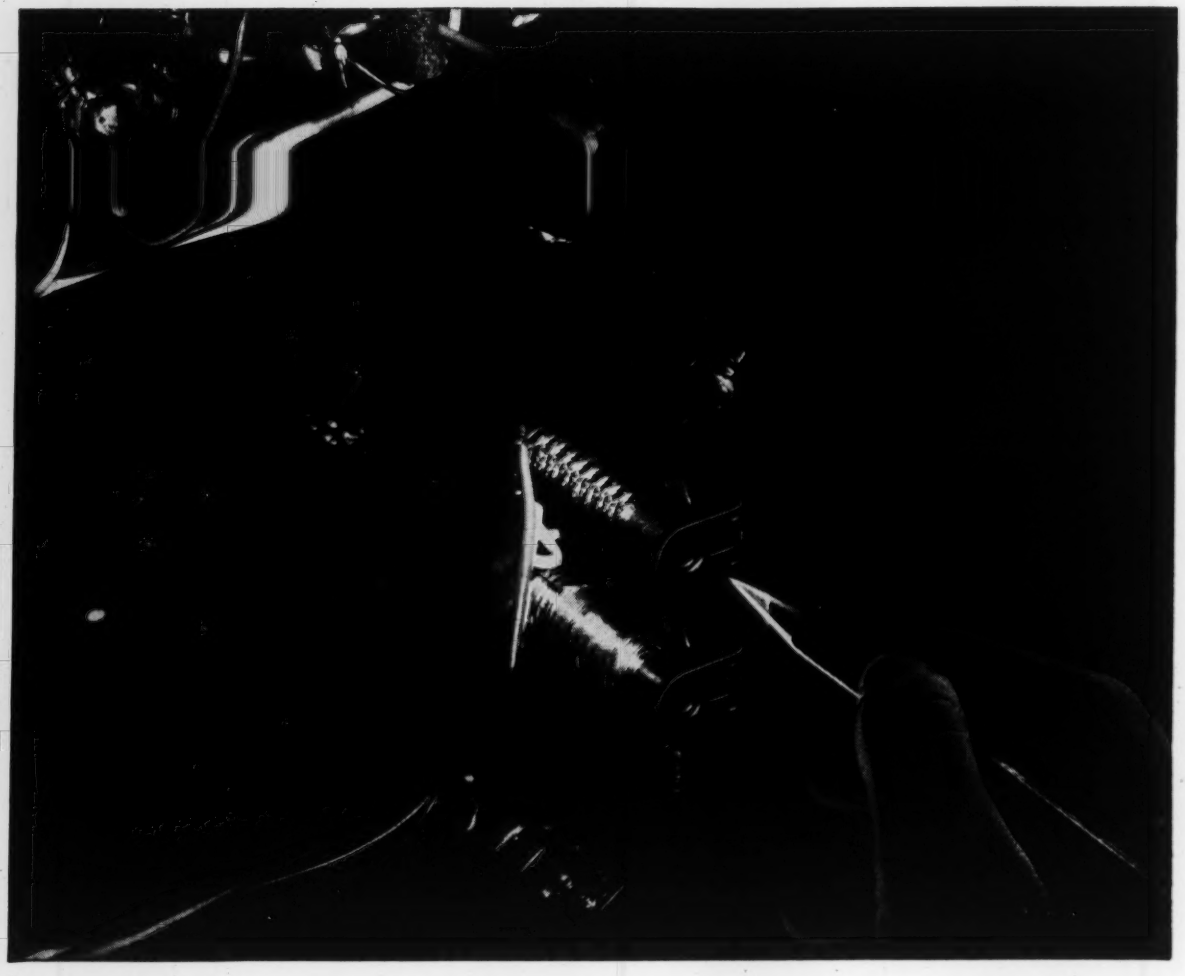
And it probably will for yours, too. So when you have a job calling for a non-deforming alloy steel—one with excellent machinability, high-strength and wear-resistance—try Crucible MAX-EL. It's promptly available from your nearby Crucible warehouse, in the sizes and grades you need. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

Write for your free copy of this Crucible Publication Catalog listing dozens of helpful booklets and data sheets.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

—ITEM 220—



Engineered by Tinnerman...

SPEED CLIP® simplifies assembly, adjustment and servicing...and saves money!

The Westinghouse Television-Radio Division, Metuchen, New Jersey, needed a fastener to fill a complex fastening requirement. Tinnerman was consulted, and developed a *special* SPEED CLIP that fit the job perfectly!

This one-piece, spring steel SPEED CLIP is assembled quickly and easily to the television tuning coil. The SPEED CLIP, with tuning coil attached, is then simply snapped by hand into twin mounting holes in the chassis to lock the unit securely in place. This SPEED CLIP cuts costs on the assembly line. And it permits fast and simple adjustment of the television tuning coils, eliminating the problem of blindly searching with a screw driver for the slot of a special hex nut.

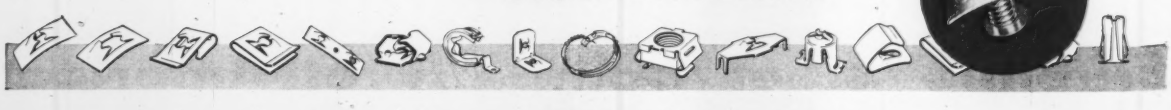
Find out how SPEED NUT Brand Fasteners can help you improve your own fastening methods. Ask your Tinnerman representative for details of our Fastening Analysis Service or write for Bulletin No. 336.

TINNERMAN PRODUCTS, INC., Box 6688, Dept. 12, Cleveland 1, Ohio

Canada: Dominion Fasteners, Ltd., Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois, (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts®

FASTEST THING IN FASTENINGS®



"Rubatex has 9 lives!"

- Soft and flexible—easy to work with
- Water and air tight
- Excellent insulating properties—permanent low "K" factor 0.3
- Extremely light—rubber cell walls only significant weight
- Permanent buoyancy—repels moisture indefinitely
- Soaks up shock—quick recovery from compression again and again
- Sanitary
- Rot and vermin proof
- Outlasts other soft materials many times over

"Nitrogen—all the advantages of air without its harmful effect—permanently sealed in my closed cellular structure—gives you an unequaled gasketing and sealing material and assures you of better performance cheaper. My 20-year performance record in automotive, aircraft, construction, industrial, packaging, radio and electronics, refrigeration and air conditioning, shoe industry, sporting goods and consumer and household products—is tested proof that I'm a versatile material well worth your investigation. Drop us a line and let us help you with your product or application."

GREAT AMERICAN INDUSTRIES, INC.
RUBATEX DIVISION, Bedford, Virginia

PIONEER MANUFACTURER OF CLOSED CELLULAR RUBBER

—ITEM 222—
For More Information Circle Item Number on Yellow Card—page 19

Hardened areas show darker at ends of rocker arm.

for accurate selective hardening of this rocker arm

...using a Lindberg 50 KW High Frequency Unit

In Detroit, a leading manufacturer of prestige autos increased production of rocker arms 300% by switching to a Lindberg 50 kw high frequency unit with a new work fixture. Production is now 1550 per hour . . . with no rejects due to unit failure.

Selective hardening of these pearlitic malleable iron rocker arms provides wear resistance from valves and push rods. A sharp cutoff of the hardness is necessary because the center hole must be kept soft for further machining.

Lindberg high frequency units give continuous 24 hour a day operation with a maximum of dependability. If you have an induction heating application, you'd do well to talk things over with a Lindberg engineer.

LINDBERG HIGH FREQUENCY DIVISION

Lindberg Engineering Company • 2473 West Hubbard Street • Chicago 12, Illinois

—ITEM 223—

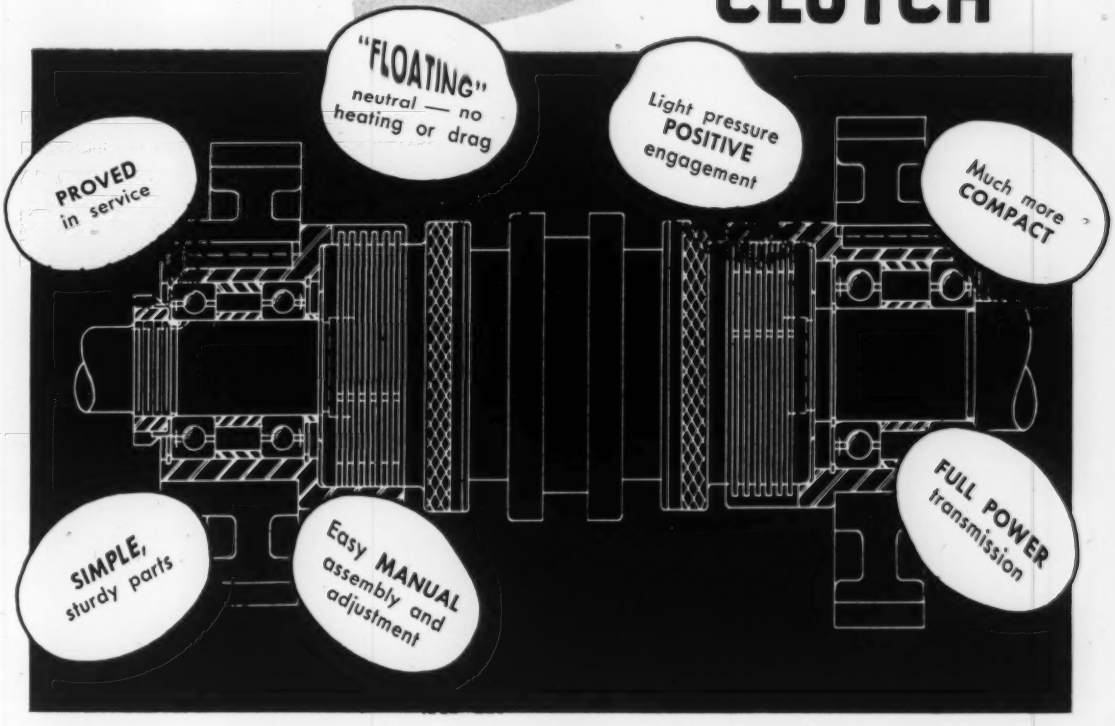
For More Information Circle Item Number on Yellow Card—page 19

BUILD INTO YOUR PRODUCT THE TROUBLE-FREE PERFORMANCE OF A

MAXITORQ

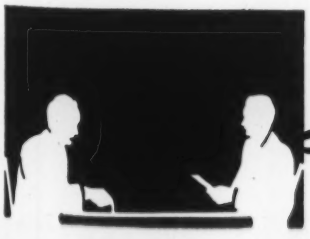
floating disc

CLUTCH


"FLOATING" neutral — no heating or drag
Light pressure POSITIVE engagement
PROVED in service
Much more COMPACT
SIMPLE, sturdy parts
Easy MANUAL assembly and adjustment
FULL POWER transmission

Here is an example of the simple, rugged, and compact installation possible with a MAXITORQ Double Clutch, with pulley-type driving cups, as the speed-change control between high and low-speed gears. Since MAXITORQ clutches, because of their exclusive design features, are always quick and positive in action while at the same time completely free in neutral, this type of installation has a well-proved record of performance to recommend it.

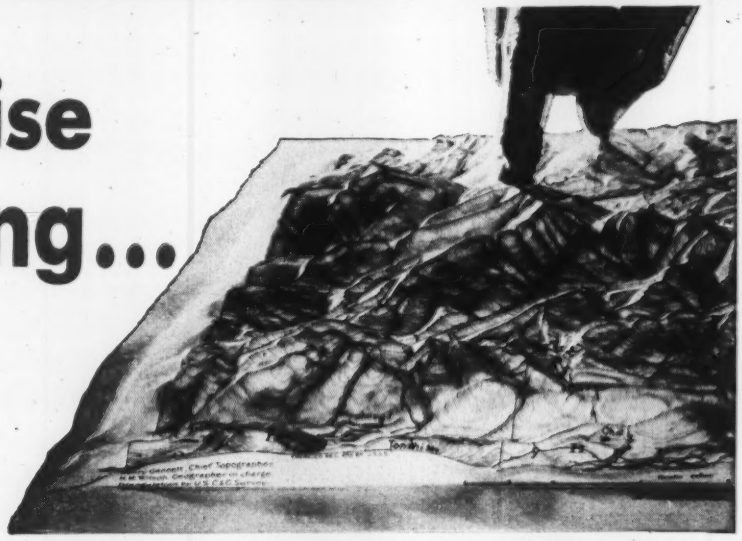
Other types of MAXITORQ Floating Disc Clutches . . . single, double, and overload release . . . are available in a wide range of stock sizes to meet the needs of a great many installations. Our engineering department also stands ready to help you with special drive problems. Write or phone Dept. MD-1. The Carlyle Johnson Machine Company, Manchester, Conn.



Let's talk **MAXITORQ**

7CJ55

For precise forming...



Molded contour map made by **Aero Service Corp.**, Philadelphia 20, Pa.

crisp, clean appearance...

"Eye-Catcher Holder" Price Tags made by **The Hopp Press, Inc.**, New York 1, N. Y.

Look at the design possibilities in BAKELITE Brand Rigid Vinyl Sheets!

They give you formed parts with all the serviceability and eye-appeal of plastics *plus* highly accurate dimensions.

For example, the price tags above come in a variety of colors or are printed with photographs in four colors, perfectly registered. Glossy surfaces enhance their appearance. Slots in the tags accommodate changing prices.

The contour relief map gives terrain details in three dimensions. It's printed flat, then formed. Peaks, valleys, and other features are shown in their proper position. The map is smooth, tough, and durable. Pencil marks can be erased.

Fabrication is neat and easy with BAKELITE Rigid Vinyl Sheets because they're so uniform in size, thickness, and properties. Rejects stay at a minimum. That's why these sheets are being used for such a variety of jobs—luminous ceilings, price tags, three-dimensional signs and drafting instruments. They're light and tough, withstand handling, chemicals, oil. A damp cloth cleans them. They resist warping, cracking, and aging.

You can get BAKELITE Rigid Vinyl Sheets in a range of widths and thicknesses—clear transparent, or colored translucent or opaque. They may help *your* product design – saleswise and functionally. Write for information to Dept. KD-103.

See Bakelite Company Exhibit at National Association of Homebuilders Exposition, Chicago Coliseum, Space #888-889, January 22-26, 1956.

BAKELITE
BRAND
Rigid Vinyl Sheets

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

—ITEM 225—

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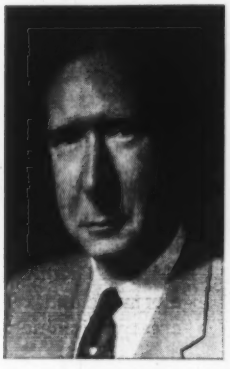


MACHINE DESIGN

JANUARY 12, 1956

Twenty-Six in Fifty-Six

THIS issue represents an important milestone in MACHINE DESIGN's history — the switch from monthly to biweekly publication. Our reasons for the change — 26 issues in '56 — were outlined on this page two months ago.

The relatively small number of pages in this new-style issue can be scanned quickly for information pertinent to the job at hand, then passed on to the next man on the routing list. This faster movement of issues through the engineering departments will keep our 100,000 readers more up to date on current developments in techniques, materials, components, etc.

Where readers may have need for more information about products announced in our pages, or wish to have copies of articles for future reference, we have streamlined the procedures for making these services available. All requests can now be made on one convenient postcard, which appears on Page 19.

Editorial policies will remain unchanged, with only slight shifts in emphasis. As always, the heart of our editorial contents will continue to be the feature articles by leading authorities on how to solve the day-to-day problems that face design engineers — technical, administrative, professional and personal.

Faster printing schedules and greater frequency of issue will permit us to present more timely items in the Engineering News Roundup section, which begins on Page 5, right after the Contents page. The New Parts and Materials and other announcement sections will, of course, be equally timely. Engineering Data Sheets, always a high-interest feature, will continue to appear in every issue, thus offering more than twice as many of these useful aids in a given period of time.

In tailoring MACHINE DESIGN to the current needs of design engineers we have been helped by readers' comments — both unsolicited and through the Eastman Research Organization and others. We take this opportunity to thank all who have helped us produce a journal that for more than a quarter of a century has served an indispensable need in the design engineering profession. We also invite comments at any time on any phase of our publication, be they bouquets or brickbats. This is your magazine.

Colin Carmichael

XUM

BRAINSTORMING

. . . a method for developing creative engineering ideas

The unique idea-creating technique known as "brainstorming" has stimulated high interest in many different fields. People who have studied and worked with brainstorming are enthusiastic because of its proved ability to generate a quantity of practical ideas.

Brainstorming has been used for some 15 years by its creator, Alex Osborn of the advertising agency, Batten, Barton, Durstine and Osborn Inc. As developed by BBDO, it has been extremely successful as an advertising and merchandising idea source.

In the past few years, however, many have realized that the brainstorming technique is equally applicable in other fields—including engineering. A few have actually attacked engineering problems by brainstorming them, with excellent results.

In this symposium, three experts on brainstorming and related methods for increasing creative imagination tell the story in their own words. The speeches on which these three articles are based were given at a recent "Inventor's Forum" at Armstrong Cork Co. Together, they depict an exceptionally well-rounded and comprehensive view of brainstorming—its methods, its history, and its relationship to individual creativeness.

Brainstorming

. . . a group attack

By **Willard Pleuthner,** *Vice President*

Batten, Barton, Durstine & Osborn Inc., New York

YOU and I know that ideas and inspiration don't just happen. Talent is there all the time, but *will* and *drive* are necessary to *use* the talent which we have.

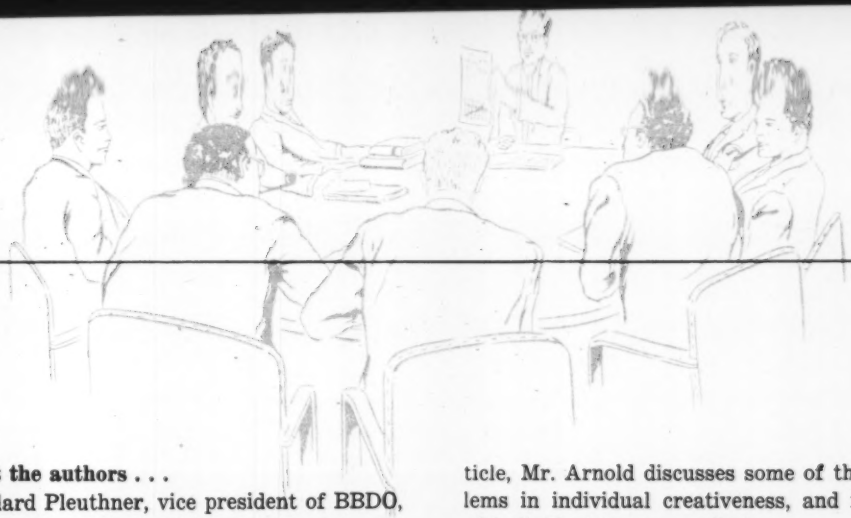
Concentration of thinking counts—the all-out concentration which the Germans call *Aufgabe.* We have to *Aufgabe* those principal projects. We have to *Aufgabe* those research plans where there's a dateline. And in those drive periods, we should avoid "scatterization" of effort. Instead of going here and there, drive down that main line toward that big project which you want to settle.

The famous rowing coach Ten Eyck used to harangue his crews with this sage advice: "If you hang on two strokes longer than your opponents, you will lick them." If you try two more times, you sometimes get that answer sooner. You may get several answers you are looking for. Experience shows that drive is often more important than ability. The intense desire to create will overcome some of our lack of experience.

In the book, *Applied Imagination,* by Alex Osborn there are several ways to speed up the development of ideas—the development of your imagination. What are they? Well, one is a deadline. Set a deadline for yourself. Say "I'm going to have so many ideas on this project by a definite date." Or "I'm going to have a quota of ideas by a certain time."

Les Pearl in our office is one of our top creative people—a copy chief. When he told his father in England he was going to be an advertising man and write copy, his father said: "Well, you've got to have a lot of ideas. I'd like to make a suggestion. I want you to get one brand-new idea every day in the year for 365 days." So Les Pearl set out to do that, and did it. He got at least one new idea per day for 365 days in the year.

Some other creative people use the technique of having seven cards. One card for every day in



About the authors . . .

Willard Pleuthner, vice president of BBDO, is in charge of the brainstorming group. He is a long-time associate of Alex Osborn, and has worked closely with Mr. Osborn in developing the methods and techniques of brainstorming. In his article, Mr. Pleuthner describes the technique of brainstorming as practiced at BBDO.

Prof. John E. Arnold, of MIT, is well-known for his unusual and successful courses in creative engineering. Most of his work has been with the individual and, in his article, Mr. Arnold discusses some of the problems in individual creativeness, and relation of individual to group efforts.

C. F. Hix Jr., who supervises engineering program courses for General Electric, has developed a number of methods for stimulating inventiveness and creative engineering. He has worked with individuals and with groups —on a variety of engineering problems from turbosuperchargers to electric ranges. In his article, Mr. Hix shows how brainstorming and individual creative techniques have been used on engineering problems.

the week. They write down on that card all the ideas they have on a particular problem on that day of the week.

One of Alex Osborn's techniques is to ask yourself idea-creating questions. Some of them are: What else is like this? What parallels does the past provide? Could other processes be copied? In what other shape or form? How to create a new look or a new color? Or motion? Or sound? The first thing you do is make your own list of idea-developing questions.

Now let's discuss "brainstorming"—the group technique which Alex Osborn developed. The psychologists would call it group ideation. But in our office, our staff members couldn't go for group ideation so the participants called it brainstorming, because you storm a problem with your brain, commando fashion.

Brainstorming started some 15 years ago, when Alex came down to New York to run our business. One of his projects was, "how do you get more ideas from more people." The resulting technique is not a substitute for any other form of thinking or conference.

He started it at breakfast; then it went to dinner sessions. The participants are indoctrinated with the problem before they attended these meetings. These brainstorm sessions are 100 per cent creativeness—production of idea after idea. There are several basic principles to brainstorming. Here they are:

Ideation is more productive when judgment is concurrently excluded. At these brainstorming meetings, no discussion or evaluation is permitted. You just ideate positively—use creative thinking—until the group rolls up between 60 and 120 ideas. There is no discussion—no can'ts, no don'ts, no sacred cows—just idea after idea.

Many tests have shown that if you just stick to that positive approach, with no evaluation, you'll get more ideas from the same number of people in a specified time than if you went back and forth between idea and discussion, idea and evaluation.

Experience shows that group ideation is usually more productive than individual ideation. That may be a shocker. I'm sure some people are saying right now, "Aw, you can't tell me that one." Maybe that's in your mind, but it actually works out. When you have the same problem and you throw it open to a group of people working on it together, you get more ideas.

We made this test on a Sheraton Motels problem. They were planning on building a new motel. Our entire agency was asked to give ideas on "What would you do if you were building a new motel—what new services would you suggest?" Questionnaires were sent to everybody in BBDO. In addition, a group brainstormed the problem—eleven creative people. This group developed almost three times as many ideas per individual as the average questionnaire. And the client tells us the ideas coming from the brainstorm group were not only greater in quantity, but were better ideas.

Another principle of brainstorming is that the more ideas we think up, the better they are. Now again you may say, "That sounds crazy—they just want quantity; they don't want quality." It's a curious thing, but by driving for a few more ideas, you get far more. First you get 30, and you want

to get 60. Then you get 60, and you want to get 75.

People just sort of mentally squeeze out those last ideas. What happens? Somebody squeezes an idea out here, and it sparks three ideas across the table. Those three ideas never would have been suggested unless somebody had squeezed out his "last idea." That's why you drive for quantity.

Here are the five rules for successful brainstorming:

1. *Set brainstorming apart from ordinary conferences.*

2. *Judicial judgment is ruled out.* Criticism of ideas must be withheld until later. Someone, or another group, goes over the ideas later.

3. *Freewheeling is welcome.* The wilder the idea, the better. It is easier to tame down than to think up. Again, this may sound crazy. But somebody throws out a wild idea; it's "way up there." The fellow across the table realizes it's wild. He says to himself, "You can't do that, but you could do this." He "practicalizes" the idea. So the higher they go, the better the ideas which practicalize the wild ones.

4. *Quantity of ideas is wanted.* Why do you need a good quantity of ideas? Because, generally, the percentage of usable ones is the same.

5. *Combination and improvement are sought.* In addition to contributing ideas to his own panel, each member is to suggest how suggestions by others can be turned into better ideas, or how two or more ideas could be combined into a still better one. These are called hitchhikes; they are welcome and wanted. For it's through the combination that you get more ideas than you would if these same individuals worked on the same problem at their own desks.

How does BBDO operate these sessions? The group consists of 10 or 12 brainstormers, creative people. They are not directly concerned with the client. They bring experience and ideas from various departments of our agency. They have been given the problem two days before in a one-page memo. At the end of this memo, we give them two examples of the kind of ideas we want. Then at the meeting, the client's account executive is there to answer questions. He can only answer questions for about five or six minutes. If he goes longer than that, he gives the policies, the can'ts, the musts, the don'ts, the sacred cows. These put the brakes on the brainstormers, and you don't get as many ideas.

Over half these people are surefire pacesetters. The rest are new people we invite. We want to spread brainstorming among as many as possible. In August, for instance, we had 24 brainstorm panels in the New York office. They were participated in by 187 different staff members. They find that brainstorming helps them on their regular jobs. They say that after they go back to their own tasks it is easier to stretch their imagination.

A secretary takes down the ideas reportorially. When a panelist breaks a rule, we ring a bell. The ideas are taken down in shorthand in reportorial fashion—two to four sentences for each idea.

No-one is given individual credit for his ideas because one fellow might not have had his idea unless somebody else on the other side of the table had had another idea. On the last page, all the people who attended are listed and given credit for contributing to the meeting.

Follow-up activities are very important. For example, you screen the ideas; you never present the boss with all those ideas because he'd be confused. So somebody screens them later and selects the best 8 or 10 or 12. He then develops them by taking the next step. This can be estimating the cost, or checking into the idea with a survey. First, show the screened ideas. Then if the boss wants to see the other ideas, you show them to him later.

By now you're saying, "Well, sounds like a crazy operation. How about results?"

The broad answer is the fact that brainstorming has been used in our agency for 15 years. We're using it more and more every month. Practically all of our business brainstorming now is for repeat customers; clients that had this service before.

Here are some specific results. For Campbell's soup, we brainstormed the problem of youth activities. How do we get kids to yell for Campbell's soup? Well, out of a brainstorm meeting came an idea which later developed into the Lassie contest—naming Lassie's pups. All Campbell's gave away were puppies. Result: Campbell's had several hundred thousand entries accompanied by soup wrappers.

For New York Telephone Co., we work on the telephone company's various problems every other month. We had one session recently on how to merchandise the new colored telephone sets. Result: 18 out of 82 ideas were used. The brainstorming session developed 82 ideas. The client used 18.

For Newcastle folding doors (that's the accordian door), we brainstormed the problem, "How do you get people to go through model homes?" By getting more people to go through model homes, more builders are friendly toward Newcastle folding doors.

This brainstorming session was most unusual; it was not average. We developed 154 ideas, Newcastle sent 153 out to their home builders.

For Easy Washer Corp., several of our offices brainstormed a name for a new combination washer and dryer. Believe it or not, we developed 993 unduplicated names. This seems impossible, but it is true.

BBDO has also brainstormed successful ways to cut office costs. We have brainstormed improvements in our clients' products. Outside organizations have secured good results in brainstorming such problems as absenteeism, cutting down on waste, and getting more production from a factory machine that is not working full time.

Brainstorming is not always the perfect way to get answers to a problem. It's not always the guaranteed answer. But we do suggest that when you have a problem, try brainstorming.

Personal Development

. . . an individual approach

By John E. Arnold *Professor of Mechanical Engineering*
Massachusetts Institute of Technology, Cambridge, Mass.

I FOLLOW a little different approach in trying to teach people how to be more effective creative producers. Since I am dealing with individuals, I take an individual approach. To me the creative process is one whereby you combine and recombine past experience, coming up with some new combination, some new pattern, some new configuration to better satisfy some need of man.

I'd like to emphasize three points in this creative process. To me creative activity must end up, first of all, with something better—not just something different. To be different, I think, is a poor excuse for inventing or designing, or for innovating of any kind. You must try to be better; you must try to solve some important need of mankind in a better fashion than it has ever been solved before.

Secondly, I think that the creative process does not end with an idea; it only starts with an idea. The process is not completed until you come up with some tangible evidence that you have gone through some creative activity—something you can feel or see or react to. Not just an idea.

Sometimes I think we get so enthused about a hundred ideas that we forget that there's a lot of work between the idea and the final end result—a lot of bugs that have to be worked out— a lot of working and reworking—before you finally get something that will work—before you finally sell the boss on the idea and he in turn sells the public. The creative process is not completed until you have some tangible result.

And lastly, I think that somehow or other, this process of combining ideas, materials, etc., is not just any old haphazard process, but somehow or other it reflects all the total inner action of the innovator, and his total environment—the ideas he works with—the materials he works with—and the processes he works with. You know that the old definition of genius meant a bringer of value, *personally marked*. And I think that this is a good definition of the creative man.

To me, creative activity is, first of all, individual activity. Nothing was ever created by two people. It is perhaps too strong to say that there are no good collaborations in music, in art, in poetry, in mathematics, in philosophy. Once the idea has been born, once this miracle has taken place, the group can build upon it and can extend on it. But the preciousness of creation lies in the lonely mind of a man.

When I say that creative thinking is individual activity, I am not saying that it cannot be group activity. Certainly I am sure that all those in favor of brainstorming (and I use it very frequently) feel that a group of highly trained individuals is more effective than a group chosen at random. So the first thing is to develop yourself as a creative, effective, efficient contributor in some creative, imaginative activity.

The blocks that prevent people from being more effective, creative producers fall into three classifications. First of all are perceptual blocks—all those things that prevent us from getting relevant, adequate, true information about the outside world.

You know that our full realization of what exists in nature is an integral part of what we view and in ourselves as viewers. It's obvious that the blonde young girl a young man gets so excited about in May has not changed her appearance at all from January until May. But the young man himself has changed somehow, so that now this blonde looks quite gorgeous where before she looked quite drab. Perception of the outside world is a joint part of the viewer and the object viewed.

Perceptual blocks occur very frequently in industry. After you have been in industry a certain length of time, you label certain things as obvious or as trivial. These don't have to be paid attention to any longer; everybody knows those things. And then some amateur comes in and looks at the obvious. He doesn't know what is obvious, obviously, and he says, "Why don't we do something about this over here." And a new invention is born.

There is another important perceptual block called "functional fixedness." You see something; you associate it with a certain process, and it doesn't change. A hammer is for pounding nails, and that's all it's good for. We are used to seeing something in a certain spot and don't think of using it in some other area.

Perceptual blocks arise frequently, I think, from a very important aspect of the creative process—correct problem statement. If you state your problem in such a fashion that you include the solution in the statement, obviously you can't look for new approaches. If you, however, become quite basic and very broad in your problem statement, then you can look at a lot of different approaches.

I have used this example in class a number of times. A problem will be sent in, involving a design of a better toaster, in effect. If you think only of toasters, you end up with some kind of device

that will use radiant electrical heat, etc. And you may make it a little prettier, or add a little more chrome here and there. You may add a butter spreader on the side, or you may make it as a do-it-yourself kit. You can do a lot of things like that, but you still end up with pretty much the same process of toasting bread.

However, if you say my problem should be one of dehydrating and browning the surface of bread, well then I can look at all possible approaches. I can use chemical approaches, electronic approaches, or radiant heat approaches. I can even use abrasive approaches.

Problem statement is extremely important. I have seen more people helped by really restating their problem very broadly than I have by coming up with suggestions. They, themselves, once they see a problem restated, can come up with all kinds of solutions to it.

There is another class of blocks, called cultural blocks. These are all the things that other people do to you, or you in turn do to other people. The products of your mind, the products of your hands, and of those long gone before you, influence the way you think. The way you were brought up in your home—the response to the questions you asked your dad and mother—have an influence on whether or not you keep on asking questions, keep on searching for new ways of doing things. If every time you come up with a new situation, a new problem to solve, someone hands you a ready-made solution, you cannot be expected to develop the creative potential you have within you. If, in the school work of your children, they spend all their time learning how to give back old answers to old questions, they certainly won't be prepared to ask new questions. The questioning spirit is essential, and this idea of having ready-made solutions always available is, I think, a terrible cultural block.

Another psychological problem is called "Einstellung." This is knowing how to do things. If you know how to proceed in solving certain types of problems, you use that pattern time after time, and it is very difficult to get out of that very successful but very prosaic rut.

The fears and phobias we have, whether we are aware of them or not, are all blocks to more effective, more efficient creative activity. We are afraid of making a mistake; we may lose our job. We are afraid of making a fool of ourselves. We are afraid of asking important questions, because that shows our ignorance. All these things are basic to, again, preventing us from being more efficient—from realizing to a greater degree the potential we have within ourselves.

How can we get rid of these blocks? I think one important thing is to try to develop a dual personality if you possibly can. Go back to Socrates and "know thyself" if possible, but if that isn't possible, then develop the ability of being both a participant and an observer. Try to watch yourself as you are engaged in creative problem-solving situations. What procedure is successful; what procedure is unsuccessful; and why? Is there some kind of unrecognized block preventing you from seeing the true, important information? Is there some unrecognized block that makes you react as you do to certain situations? Do you avoid certain areas of thinking? Do you reach quickly for a tried and true solution rather than search for a better solution?

Each individual should try to develop his own potential to the utmost. Dream the biggest dream you possibly can; think the biggest thought you possibly can; ask yourself the biggest question you possibly can. Don't accept, except under great duress, something less than that big dream, if you possibly can.

Planned Training

. . . a composite method

By C. F. Hix Jr., *Supervisor of Engineering Program Courses*

General Electric Co., Schenectady, N. Y.

I AM sure you're aware of the current shortage of engineers. Back in the early 30's, the management of General Electric Co. was faced with the same kind of shortage of inventors—the people who had been instrumental in making General Electric the company that it is. The management of the company became quite worried, and they wanted to do something about it. In 1936, they started with a program which ultimately became the creative engineering program for young engineers. It also led to other courses for engineering people within the company.

During these early years, we hunted around for all kinds of techniques—anything that would give us a clue to develop this creative potential. We borrowed ideas; we borrowed techniques; we created a few of our own. Probably the biggest contribution to our efforts is the brainstorm technique that we got from Alex Osborn.

We decided we would study the problem of what is an inventor; how does he think; does he organize his thinking or doesn't he organize his thinking;

where does he get his ideas; how does he get them. Through all of this mystery that we could see in front of us, we began to get a rather clear picture of how people go about solving problems.

We found that there is a rather definite period in people's thinking when they are very frustrated with a problem—they are trying to define it, trying to get a concept of the problem. There is a period where they begin to think about ideas for methods of solution, i.e., gathering thoughts. There is a period in which they began to evaluate these ideas. They then go through a period of selection and ultimately the long, tedious follow-through

Applying Creative Engineering Techniques

A PRACTICAL case history can be followed in the early development of an continuously adjustable heat control for the General Electric range, as done by the engineers on the Creative Engineering Program:

1

Step 1: *Recognize*—Although five specific heats are sufficient to perform all surface cooking operations satisfactorily, a need has been expressed for in-between heats to compensate for differences in heat transfer that result from the type, quality and condition of cooking utensils. It is generally the feeling that the consumer will not pay a premium for this additional flexibility, and the problem, therefore, is to develop a low-cost continuous heat control for the surface units of an electric range.

2

Step 2: *Define*—A word definition would be: "A new low-cost control for the electric range is desired to promote the ease of cooking and sales appeal." Specifications were:

Continuously adjustable control of heat
Retention of console theme and control-panel design
Easily cleaned control panel
Long life
Reliability
Low cost ($1.50 per control)
No radio interference
Fast heating
No-burning feature desirable.

3

Step 3: *Search for Methods*—To find a method that would meet the specifications arrived at in Step 2, the engineers applied creative techniques, for making a number of possible suggestions to solve their problems. Of the 65 ideas suggested in the report, a few of the categories and some of their resulting ideas were:

1. Mechanical *on-off* heat controls
   - Common cycling methods
     - Motor driven
     - Solenoid driven
   - Constant or variable-frequency oscillators
     - Thermal bellows
     - Time-delay relays
     - Electrostatic clutch
     - Thermistors
     - Bimetal oscillators
   - Vibrating or resonant devices
     - Escapement devices
     - Variable damped resonators
2. Electrical methods of heat control
   - Potentiometer spanning small increments
   - Autotransformers
   - Variable core reactors
   - Gas-tube saw-tooth generators
   - Rectifiers
   - Induction heating
3. Other methods of heat control
   - Vary losses from heating unit
   - Vary mass of heating unit
4. Types of actuation
   - Turn a dial
   - Move a slider
   - Press kinky tube
   - Press hydraulic tube

4

Step 4: *Evaluate*—Analytical and empirical methods were used in determining the feasibility of operation of the suggested ideas, and much creative thought was needed to properly combine and integrate the good ideas into worthwhile proposals. In this problem, the engineers through a series of combinations, arrived at six theoretically practical proposals.

5

Step 5: *Select*—Selection of the basic idea to be developed later was made by comparing the six proposals with each other, thereby establishing a reference for judgment. The selected idea—a bimetal reed that alternately applied and removed electric power to the heating element—resulted from combining three of the ideas in the Search-for-Methods phase. The reed completed the power circuit at both ends of its oscillation, the total power being varied by changing the reed's length of travel, thereby varying the proportion of *on* time to *off* time. The resultant control was continuously adjustable and independent of line voltage and ambient temperature.

6

Step 6: *Preliminary Design*—A prototype was constructed, tested, and redesigned to provide low cost and ease of manufacture. From a sketch of a manufacturing floor plan, the cost appeared to be 38c on an annual production of 25,000 units—considerably less than the goal of $1.50.

7

Step 7: *Demonstrate*—After seeing results and model, engineers in the range development section of the company's Range and Water Heater Dept., Major Appliance Div., were immediately attracted by the low-cost solution to this old problem achieved through application of the creative approach.

8

Step 8: *Follow-Through*—Additional work by the engineers at the Range and Water Heater Dept. has demonstrated the feasibility of the solution that is currently undergoing refinement.

From "Creativity Can Be Developed" by C. F. Hix and D. L. Purdy, *General Electric Review*, May, 1955.

that's necessary to perfect and put into practice the solution to the problem.

Along with this rather patterned way of thinking of (1) define, (2) search, (3) evaluate, (4) select, and (5) follow-through, there were a lot of other techniques.

These techniques were very useful in setting the mood for a creative attitude, and increasing the receptiveness to ideas. We found that this brainstorm technique was very effective in creating this environment. Here we could specifically take a group of people, set them aside, give them rules that permitted no negative thinking, and convey to them this concept of receptivity. It allowed us to actually teach people to generate a mood for reception of ideas.

We added to these techniques such things as the idea of check lists—questions to ask yourself about a problem. We added to our list a notebook of some 150 new laws or effects that might be useful in sparking or stimulating an engineer in looking for a solution to a problem. We set for ourselves a goal of at least eight ideas or eight solutions for a particular problem. This particular eight-item technique came from one of our rather noted inventors, Chester Hall, who had some 300 patents to his name before he passed away a few years ago. He could come up with those eight successful ideas in less time than it took me to even think of one. But he practiced a philosophy: He wouldn't proceed to evaluate any of these ideas until he had at least eight workable methods.

Another technique which we have added recently is to establish in the very beginning how much it is worth for you to work on the problem. We've been very surprised at the number of contributions that have been made because engineers have taken time to figure out that the problem was really worth solving. They didn't have to pass it off as being something to put off until tomorrow. They could see the dollars and cents value of a potential solution.

I have already mentioned the patterned problem approach—the define, search, evaluate, selection, etc. We have found that this has been very effective with our younger engineers in helping them improve their efficiency in getting oriented to problems. It helps them organize their time.

In fact, it's hard to go anywhere in the General Electric Co. among our engineering organizations today and find them not using a problem approach of this type. We call it the creative approach to problem solving. For instance, in the General Engineering Laboratory recently, we got a request from one of our operating departments to come up with a new product. They wanted something so you could turn on a lamp when you walked into the room, so you wouldn't fumble trying to find the lamp switch, knock the lamp down, fall over a chair, and break your leg.

They took time to define their problem. They set up two weeks to define it, and a week to search for methods to find an answer. They had some brainstorm sessions. At the end of this time, they made a proposition to the operating departments that for a certain figure and a certain length of time, they would have a device to meet the specifications. The operating departments decided they would spend the money and give the go-ahead. General Engineering Laboratory followed through the rest of this process and, at the time set and within the budget, they came up with what is now being marketed under the tradename of "Touchtron." You simply touch the side of the lamp and the lamp turns on. You touch it again and it turns the lamp off.

We feel very definitely that these courses work. First of all, we know that the demand for graduates of these particular programs far exceeds the proportional demand for graduates of engineering schools; our program graduates prove themselves to the operating departments. We know, for instance, that the graduates of our training program are producing approximately three times the number of patents that engineers who come from other sources produce. We also know that, with seminars for older engineers, patent productivity in the department is increased. One department reported to me that they had made a threefold increase in their patent productivity.

We have learned a number of things besides the fact that the creative engineering program stimulates inventiveness. We've also found that it has led us to a new concept of management. We've learned some of the things that it takes to stimulate creativeness. It has got our whole company thinking about, "How do you set this environment on a company-wide basis?"

One of the last things it has taught us is the fact that few ideas are in themselves practical. It is for the want of an active imagination in their application rather than in their means of acquisition that they fail of success. In other words, it's continued imagination—continued creativeness with respect to the original concept—that makes the ideas work.

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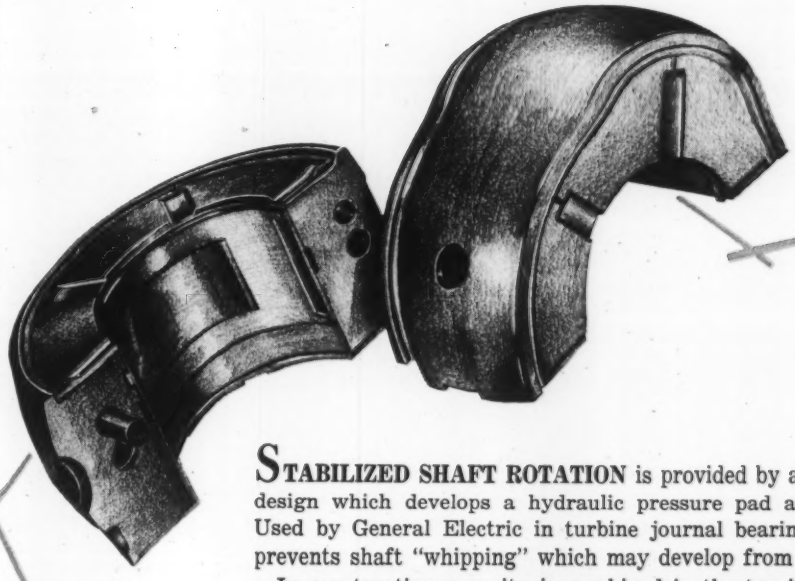
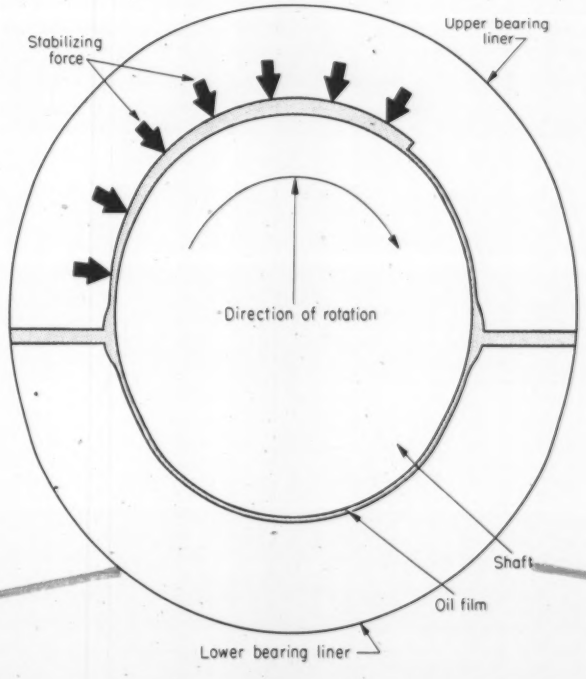
scanning the field for *Ideas*

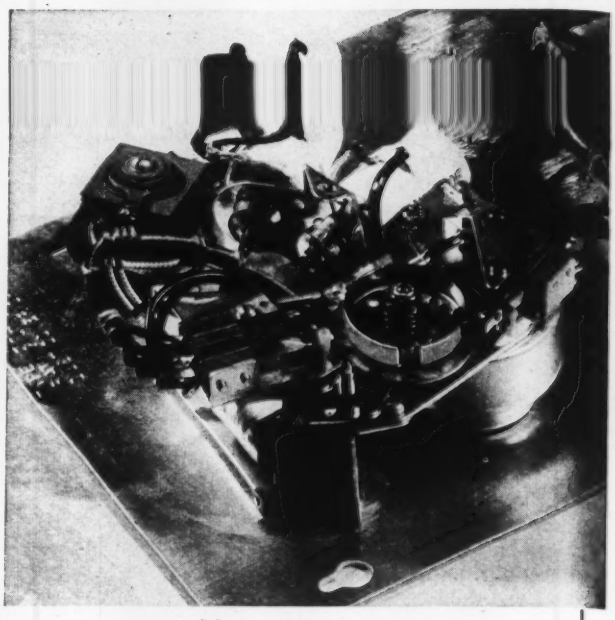


STABILIZED SHAFT ROTATION is provided by a novel bearing design which develops a hydraulic pressure pad at high speeds. Used by General Electric in turbine journal bearings, the design prevents shaft "whipping" which may develop from oil film whirl.

In construction a cavity is machined in the top insert linear of the bearing to create a dam which restricts oil flow around the shaft. The viscous pumping action of the shaft causes oil pressure to increase in the cavity as speed rises. This increased loading forces the shaft down into the lower bearing half and minimizes the possibility of vibration.



SELECTIVE AUTOMATIC SWITCHING of

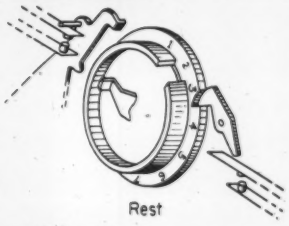


any one of several electrical loads connected to the same power circuit is offered by an electronic relay design which requires no separate control-circuit wiring. Operated by dual-coded signals superimposed on conventional ac power circuits, these devices respond only to special combinations of pulse frequencies and pulse codes. The relays were developed by International Business Machines Corp. to automatically control electrical equipment from central control stations and are capable of distinguishing between any one of ten *on* and ten *off* codes on the same frequency.

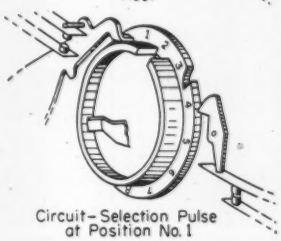
In design, the relays are made up of two basic units: a simple electronic receiver designed to accept only one signal frequency and an electromechanical decoder which is pulse-code sensitive.

To operate these relays, first a *start* pulse of proper frequency, and duration, must be received. The instant such a pulse is detected by the receiver it is passed on through a cold-cathode tube to a selection magnet which closes the decoder motor contacts (not shown), starting rotation of the decoding cup. If cup rotation is maintained for more than 2 seconds, a motor cam closes a motor holding circuit and keeps it closed for one revolution. Complete rotation of the cup requires 60 seconds. Then 2 seconds after the 3-second start signal has been received any one of ten 3-second *circuit-selection* pulses detected during the next 50 seconds will cause the selection magnet to attempt to pull the *signal-contact lever* into the decoder *gate*. If a proper pulse signal appears when the signal-contact lever is aligned with the gate, the lever enters the gate and, with further rotation of the cup, cannot escape. The decoder cup continues to revolve and during the final 5 seconds of rotation the *signal-duration cam* further depresses the signal-contact lever to close the *signal contacts*. This action energizes the *off*-function circuit to the electrical load unless a 4-second *on*-command pulse is detected in this period; then the selection magnet will open the *off*-circuit contacts and close the *on*-circuit contacts.

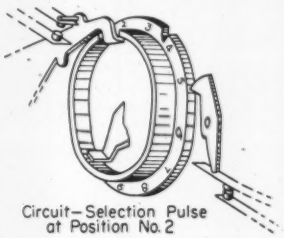
At the end of one revolution, the motor cam drops into a notch on the decoder cup breaking the motor holding circuit. The decoder will begin to rotate again at the next *start* pulse of proper frequency. If a *circuit selection* pulse timed to correspond with the decoder gate position does not appear during the next cycle, the contact lever will escape through the gate, thus preventing closure of the signal contacts near the end of revolution.



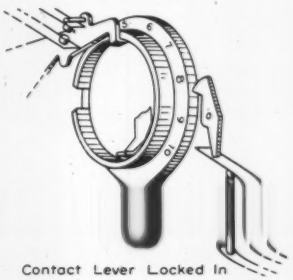
Rest



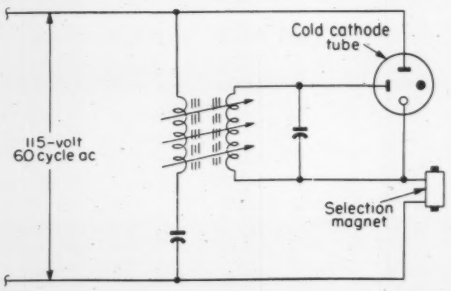
Circuit–Selection Pulse at Position No. 1



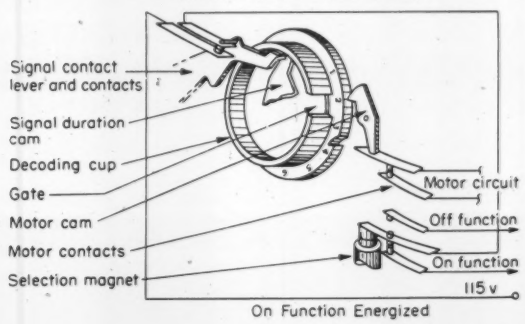
Circuit–Selection Pulse at Position No. 2



Contact Lever Locked In



Single-Frequency Receiver



On Function Energized

An Approach to

WEAR EVALUATION

A new method of determining characteristic wear rates of materials for practical design use

By A. Siede and V. Pulsifer
Armour Research Foundation of Illinois Institute of Technology Chicago

THERE are a multitude of test procedures for evaluating wear, none of which bear any known relationship to another. Few engineers use test machine data without reservation, and the only reliable method of evaluation is on the basis of field data. New combinations of wear elements and conditions are not used unless prior experience can be found with closely similar conditions or unless limited service experience is at hand.

Many wear tests are based on comparative wear properties of two different materials against a third material. Other tests, more scientific in nature, determine wear rates of specific wear couples, at specific pressures with specific lubricants being used. These tests yield results which are considered more reliable, and which can be used with less hesitation providing field conditions have been carefully determined. The main objection to such a wear test is that by its very nature the test conditions are rigidly fixed. The question then arises, "What happens to the wear rate for a specific wear couple when the operating pressure or the lubrication is changed?"

A wear testing machine designed and constructed at Armour Research Foundation of Illinois Institute of Technology gives one possible approach to the answers to these questions.

Construction: The wear couple being tested consists of two cylinders, *Fig.* 1, placed at right angles to each other. The cylinders are brought into contact by means of a lever arm and fixed weight. Force at the point of contact is thereby known. The bottom cylinder is rotated at a fixed speed, and the number of revolutions is recorded by a counter machine attached to the cylinder. The cylinders can be lubricated by various means.

Initially, the contact area of the wear samples is quite small, approaching point-to-point contact for high-strength materials. As the bottom wear sample revolves, material is worn away from the top wear sample. The wear process increases the contact area and conversely lowers the contact pressure. In operation, the top sample wears faster than the bottom sample. The wear spot formed on the upper sample is in the shape of an ellipsoidal segment. The contact pressure of the wear samples can be found by measuring the area of the wear spot, computing the projected area, and dividing the acting force by that area. In this manner, the contact pressure can be determined for any given number of revolutions of the bottom wear sample.

The volume of material worn away on the top wear sample can also be determined by weighing or by computation. In the tests performed at Armour

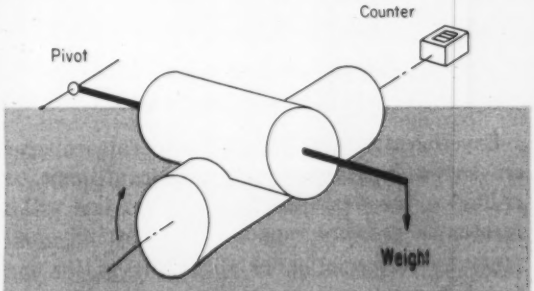


Fig. 1 — Schematic showing basic design of the Armour wear-testing machine

Table 1—Typical Value of Wear Constants

Materials	n	K
Hard carbon on hard carbon (dry)	34.3	5.12×10^{-96}
Beryllium copper on hard carbon (dry)	10.9	2.38×10^{-48}
60-40 brass on tool steel (dry)	1.80	3.86×10^{-12}
Nitrided Nitroloy on nitrided Nitroloy (dry)	1.13	7.94×10^{-9}
Stellite on tool steel (dry)	1.53	5.60×10^{-8}

WEAR EVALUATION

Research Foundation the mathematical solution is used since the volume can be measured without disturbing alignment of the wear samples.

On the basis of three assumptions, the wear rate, (dv/dc), can be expressed as the function:

$$\frac{dv}{dc} = Kas\,P^n$$

where a = area of contact; s = distance traveled; P = contact pressure; and K and n = constants depending on the material, lubricants and other physical conditions such as temperature.

The assumptions for the basis of this equation are:

1. The volume of material removed per cycle is directly proportional to the distance traveled.
2. The volume of material removed per cycle is directly proportional to the rubbing area for a given contact pressure.
3. The volume of material removed per cycle is a power function of the contact pressure.

Experimental Data: Some of the data collected are shown in *Fig.* 2. Plotted in logarithmic co-ordinates, the wear rate is a straight line within reasonable pressure ranges. At excessively high pressures, deformation or shattering of the materials being tested obviates the use of this equation in this region.

From the data collected, an engineering approach to wear has been established. For example, assume a machine is to incorporate a wear number operating at 500 psi. From the data in *Fig.* 2 the bronze couple shows less wear below 200 psi. However the wear rate of this combination changes markedly with pressure and the bronze-steel couple would be a better choice in the pressure range of 200 psi and higher. From a collection of data of this type, it is simple to select the best material for specific applications.

When the experimental values are obtained and plotted on log-log co-ordinates as shown in *Fig.* 2, the values for n and K are respectively the intercept at unit pressure, and the slope of the line representing the data.

Typical values of n and K are given in Table 1.

Typical Applications: A firm used a case-hardened steel pin riding on a hardened steel cam lubricated with high-grade mineral oil. The oil was fed to the cam surface by gravity and centrifugal force from a felt pad reservoir. Simulated life test results were erratic, with some pins showing excessive wear, whereas others ran indefinitely. A quick calculation of the pressures involved and comparison with comparable wear rates for these materials showed that the only possible cause of failure was loss of lubricant at the wear surface during running. A change in the method of feeding the lubricant was made which eliminated the failures in the simulated life tester and eliminated service failures in the field.

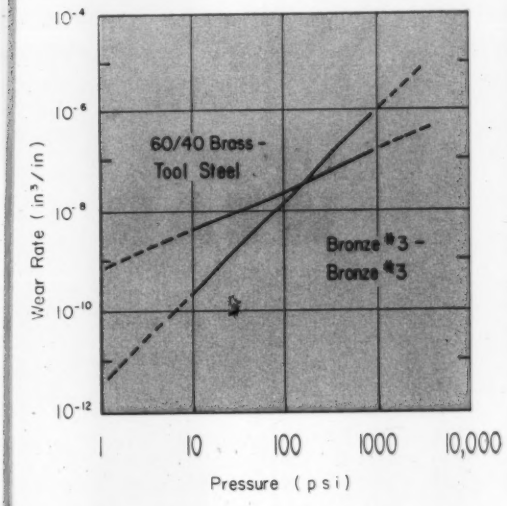


Fig. 2—Examples of characteristic wear rates obtained experimentally with the use of the Armour wear-testing machine

In another problem, a firm desired to eliminate the use of oil or other hydrocarbon lubricants due to the tendency for erratic functioning of the company's precision mechanism in variable weather conditions. Wear rate as a function of pressure was determined for suitable dry-running materials. One combination was found to fulfill the life requirements for this application, and eliminate the variable performance due to the weather dependence of the lubricant.

They Say . . .

"An automatic machine must be more reliable than a manually controlled one, because it produces faster, and without supervision can spoil more work before a malfunction is detected. At the same time, automatic machines are, of necessity, more complex. If the complexity of function is achieved at the expense of more components, industry is posed with a dilemma, since failure rate rises exponentially with the number of components. To combat this trend, much work has been done on checking methods, particularly for computers, and in means for detecting incipient failure. Also, statistical means are being investigated to utilize the multiplexed output of a great number of unreliable components in parallel. But none of these is a substitute for economical design and the use of reliable components well within their ratings. The immediate future of automation may well depend on how seriously designers take these precepts."—*R. J. Bibbero, Hillyer Instrument Co.*

Electric-Motor Braking

By John C. Ponstingl
Consulting and Application Engineer
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ELECTRIC-MOTOR drives in machines of all kinds—electric trains, industrial processing machines, automatic elevators — require greater control accuracy and operating reliability as speeds increase. One major phase of control in these drives is braking. In any machine requiring braking there are two major design considerations involved: (1) determination of the braking requirements for a particular application and (2) selection and application of a braking method to satisfy these braking requirements.

To aid the designer in applying electric-motor braking, most of the design factors to consider are included in the check list in *Table* 1. Picking the best answer for a particular machine involves recognition of the braking requirements plus a fundamental knowledge of the basic advantages and limitations of each available braking scheme. Often, for a given application any one of a number of braking methods might be used. Sometimes more than one system offers the most practical solution. For example, on elevators a combination of three types of braking is usually employed—regenerative, dynamic, and friction.

Although this article is devoted primarily to all-electrical methods of internally braking electric-motor drives, comparisons are made with other basic braking methods. Only when proper comparisons are made will the most practical and economical system become apparent.

Braking Requirements: Perhaps in the most general sense braking may be defined as the process of producing a retardation torque. This retardation effect may be used for five basic drive functions:

1. Speed control
2. Torque (or tension) control
3. Deceleration
4. Stopping
5. Holding

In the first two items braking is employed for the purpose of regulating or limiting either speed

Table 1—Electric-Motor Braking Check List

Braking Requirements		External Braking Methods
1. Retardation for speed control	13. Motor horsepower	28. Eddy-current braking
2. Retardation for torque (tension) control	14. Motor torque	29. Friction braking
3. Deceleration	15. Load torques	30. Hydraulic braking
4. Holding	16. Overhauling loads	31. Magnetic-particle braking
5. Stopping time and consistency	17. Speeds and speed changes	
6. Braking duty cycle	18. Friction losses	Internal Braking Methods
7. Accuracy of stopping	19. Moment of inertia	32. Dynamic braking by ac excitation
8. Effects on machine, process, humans or animals	20. Momentum	33. Dynamic braking by capacitors
9. Reliability	21. Size and weight limitations	34. Dynamic braking by dc excitation
10. Fail-safe features	22. Braking heating limitations	35. Dynamic braking by resistors
11. False operation prevention	23. External brake mounting	36. Plugging
12. Reversal prevention	24. External brake connection	37. Regenerative braking
	25. Electric power	
	26. Wiring	
	27. Controls	

and/or torque and may not actually involve a reduction in speed. For example, on overhauling type loads, such as are produced in trains going downgrade or cranes and elevators, a retarding action is needed to control or limit increases in speed for obvious reasons. Then, too, braking can be quite useful in applications where torque or tension control is required as encountered on machines for winding material on rolls or textile machines, *Fig.* 1, where thread tensions are critical.

The functions of deceleration, stopping and holding are perhaps more obvious uses of braking. Without a deceleration torque, the flywheel effect prevalent in many machines such as printing presses or punch presses would let rotating members coast for a long time after the drive motor was de-energized. Often long stopping times cannot be tolerated from the standpoint of both production and safety. In the case of a rubber calender, *Fig.* 2, it may be necessary to stop the rolls practically instantaneously to prevent injury to the operator.

Time required to stop any rotating member in a machine is directly proportional to the flywheel action of the member and inversely proportional to the retarding forces including friction and load on the machine. More accurately,

$$t = \frac{wk^2(\Delta N)}{308\,T}$$

where (ΔN) = speed change, rpm; t = time to produce speed change, seconds; wk^2 = total moment of inertia as referred to the motor shaft or the point where braking is to be applied, lb-ft^2; and T = total decelerating torque contributing to

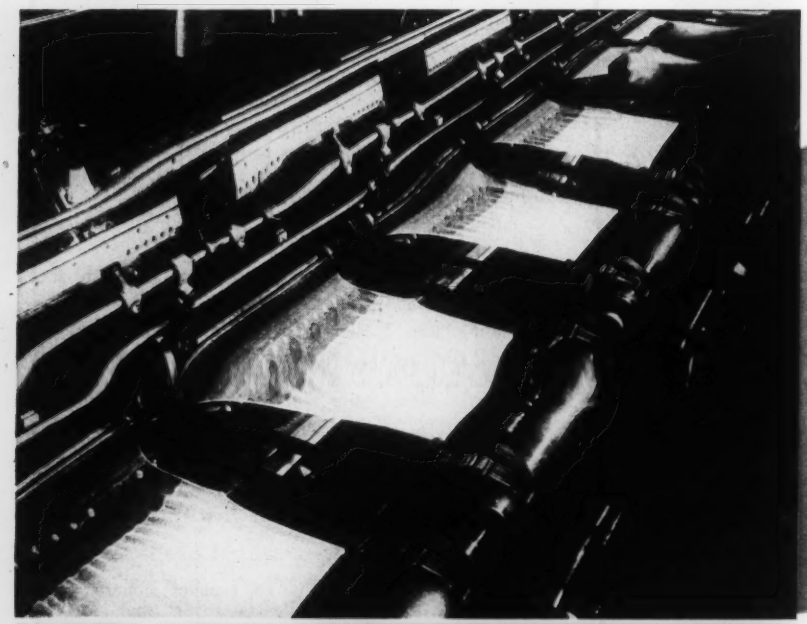


Fig. 1 — Nylon hose making machine requiring accurate braking control to maintain proper thread tensions

Fig. 2—Rubber calender driven by a synchonous motor uses dynamic braking to stop rolls quickly

the braking action as referred to the motor shaft or the point where braking is to be applied, lb-ft. This formula can be used only when torque T is substantially constant. If this torque varies considerably, calculations should be made in time increments and the average decelerating torque during each increment should be used. Increment size depends on the accuracy required, but fair accuracy is obtained if the minimum decelerating torque is not less than 50 per cent of maximum torque in a given increment.

With a given stopping or deceleration time t, total decelerating torque is determined by the expression

$$T = \frac{wk^2(\Delta N)}{308\,t}$$

It is important to note that the total decelerat-

Table 2—Characteristics of Electric-Motor Braking Methods

Method	Basic Operation	Applicable Motor Types	Special Motor Requirements	Special Control Elements	Special Requirements to Produce Braking
External Braking Methods					
Eddy-Current Braking	Magnetic coupling unit mechanically connected to motor develops eddy-currents which produce braking load	All types	Shaft extension or housing modification to accommodate brake	Brake control, usually dc	Excitation power and motor rotation
Friction Braking	Friction elements (shoe or disk) electrically, mechanically, pneumatically or hydraulically actuated produce braking load	All types	Shaft extension or housing modification to accommodate brake	May need brake relay	None
Hydraulic Braking	Hydraulic pump type device mechanically connected to motor produces braking load	All types	Shaft extension or housing modification to accommodate brake	Hydraulic brake control	Motor rotation
Magnetic-Particle Braking	Magnetic-particle (dry or fluid) coupling mechanically connected to motor produces braking load	All types	Shaft extension or housing modification to accommodate brake	Brake control, usually dc	Excitation power
Internal Braking Methods					
Dynamic Braking by AC Excitation	Application of ac single-phase power makes motor operate like a generator	Three-phase squirrel-cage and wound rotor	None	Control to apply ac power	Ac single-phase power and motor rotation
Dynamic Braking by AC Excitation of Special Winding	Application of ac voltage to special winding makes motor operate like a generator	Three-phase squirrel-cage with special windings	Special windings	Control to apply ac power	Ac single-phase power and motor rotation
Dynamic Braking by Capacitors	Capacitor provides dc excitation so motor operates like a generator	Three-phase squirrel cage	None	Capacitor and resistor	Motor rotation
Dynamic Braking by a Capacitor-Resistor-Rectifier Circuit	Discharge of dc power from capacitor into motor makes motor operate like a generator	Most single-phase types; three-phase squirrel cage and wound rotor	None	Capacitor, resistor and rectifier	Motor rotation
Dynamic Braking by DC Excitation	Application of dc power makes motor operate like a generator	Most single-phase types; three-phase squirrel cage and wound rotor	None	Control to apply dc power	Dc excitation power and motor rotation
Dynamic Braking with Resistors	Motor operates like a generator and pumps power into a resistor load	All dc types if field excitation is maintained; ac-dc universal; ac synchronous with dc excited fields	None	Control to connect resistor to motor	Dc excitation power and motor rotation
Plugging	Power lines are disconnected and reconnected to produce a reverse motor torque	Most three-phase types; single-phase repulsion (special); ac-dc universal; dc shunt, permanent-magnet and series	Zero-speed switch, if used shaft extension	Reversing control; may need plugging resistor for dc motors	Electric power
Regenerative Braking	Motor operates like a generator when it runs above normal or synchronous speeds and pumps power back into the line	Most ac and dc types except synchronous	None	None	Electric power and rotation above normal or synchronous speed

ing torque contributing to the braking action includes such factors as frictional forces in the rotating system plus the existing work loads as well as any controlled braking torque that may be applied. Although frictional torques and loads are often overlooked, they may play an important part in the braking cycle. All these torques must be referred to the motor shaft or the point where braking is to be applied.

Thus, the necessary braking torque can be calculated from

$$T_B = T - T_L - T_F$$

where T_B = braking torque, lb-ft; T_L = load torque, lb-ft; and T_F = frictional torque, lb-ft.

In many applications, loads such as flywheels are connected to the motor through a gear transmission. The value of the ratio of flywheel wk^2 referred to the motor shaft to flywheel wk^2 equals the value of ratio of flywheel-shaft speed to motor-shaft speed squared or

$$\frac{(wk^2)_m}{(wk^2)_f} = \left(\frac{N_f}{N_m}\right)^2$$

where subscripts m and f refer to motor and flywheel, respectively.

If a weight, in translation, such as an elevator cab, is to be braked by a motor, the wk^2 produced at the motor shaft is given by

$$wk^2 = \frac{PS}{(2\pi N_m)^2}$$

where P = weight of cab, lb; S = cab speed, fpm; and N_m = motor speed, rpm.

The braking cycle is an important design consideration. In the case of a rubber calender, *Fig.* 2, the braking forces may be quite high but for a short time interval. Although heat dissipation may not be a problem here, special consideration must be given to the effects these high forces may have on machinery parts as well as driving motor and work load. Heat dissipation does become a major problem in a braking application where a safe speed must be maintained for many miles while a train is going downgrade.

Braking Methods: There are many braking methods available to choose from as shown in *Table* 2. Each has its particular characteristics, some desirable and others undesirable, depending on the particular application. The holding characteristic of a friction brake may be undesirable on a machine tool, for example, where braking is necessary and yet at standstill the operator may be required to rotate the clamped work piece manually in the spindle for inspection or orientation relative to some other operation. In another application, such as an elevator, the holding action of the friction brake may be highly desirable.

Since each application has its own particular braking requirements, it is desirable to catalog the braking methods according to their common denominators, to simplify selection.

Electric-motor braking systems fall into two

Table 3—Electrical Braking Terms

Dynamic Braking: Method of quickly slowing down certain types of ac and dc motors by causing them to operate like heavily loaded generators *below* normal or synchronous speeds. Rotation is necessary to produce any braking action. While running at any speed, part or all of motor circuit is disconnected from the lines and reconnected to a resistor or part of the motor winding. In any motor, other than permanent-magnet types, some means must be made to maintain or provide field (or stator) excitation to create generator action.

Plugging: Braking method accomplished by reversing or reconnecting the power-input leads to certain types of ac or dc motors running at any speed. This action develops a countertorque which tends to rotate motor in the opposite direction.

Regenerative Braking: Retardation effect which occurs in any electric motor when speed *exceeds* normal or synchronous values. Motor must be connected to power lines. Braking action is produced because motor is forced to operate like a generator. Thus, the motor loads itself by feeding its own generated power back into the lines. Braking effect automatically produced; in fact, it cannot be prevented as long as the power lines are connected but the retardation force under such conditions is usually desirable. This type of braking may occur either when motor speed is increased mechanically by overhauling loads, such as happens with an electric train going downhill or with a loaded crane, or when electric-power or motor-circuit characteristics are changed to cause motor to rotate at a slower normal speed.

Table 4—Comparison of Internal and External Braking Methods

Internal Braking (Electrical)	External Braking (Physically-connected brake unit)
Stopping and Holding Power Retards or decelerates motor but does not provide holding power. Plugging will provide a countertorque at standstill.	May or may not provide both retardation and holding power. Depends on system used.
Overspeed Control Regenerative braking excellent for overhauling type loads or positive slowdown in multispeed or adjustable speed motors.	No better for overhauling type loads or positive slowdown than any other braking requirement.
Speed and Torque Regulation Most type can be used to maintain a controllable retarding torque for speed or torque regulation applications for any extended period of time.	May or may not be able to successfully maintain a controllable retarding torque for speed or torque regulation applications. Depends on system used.
Space Requirements No extra space required on motor or motor shaft for braking equipment although motor size for a given horsepower rating may be larger.	Extra space required on motor or motor shaft for braking equipment.
Inertia Adds no additional moment of inertia to motor.	Adds additional moment of inertia to motor and its mechanically connected loads.
Power Requirements Electric power always required for braking—either supplied or generated within motor.	Electric power may or may not be required at the time braking is applied. Depends on system used.
Heating Produces heat in motor.	Produces no heat in motor, but does produce heat in braking device.

broad categories: internal braking and external braking. Basically, internal braking systems electrically produce braking actions or torques between the motor rotor and stator such as plugging, dynamic braking or regenerative braking. These terms are defined in *Table* 3. External braking systems must be physically coupled to the motor to produce braking action such as friction brakes, hydraulic brakes, magnetic brakes (eddy-current or hysteresis) or magnetic-particle brakes (dry or fluid). There are certain basic factors which are characteristic of the two braking approaches, and some of these are shown in *Table* 4.

Internal all-electric braking methods are best suited where

1. A holding action is not needed such as on a metal-working machine.
2. Braking provisions or space are not available for coupling a brake device.
3. Motor shaft-extensions are not available.
4. Adding wk^2 to the motor is undesirable because of the high cyclic nature of the application such as on a planer or screw machine.
5. Many similar machines are tied into one power system, and regenerative braking is beneficial because of power savings.
6. Countertorque action is needed to maintain a tension even at standstill such as in textile or metal-processing machines.

In the accompanying tables are cataloged most of the all-electric internal braking systems for electric motors along with their characteristics and typical speed-torque curves. The speed-torque curves are valuable in showing the degree of braking torque applied at different speeds of the motor. Some torques are low at the high speeds and increase as the motor slows down as in the case of dynamic braking by dc excitation on a squirrel-cage motor. This characteristic may be desirable where considerable backlash exists in a machine. The soft application of braking would impose less impact to the parts thus giving greater expected life to the mechanical parts.

In reviewing the various electrical braking methods, they can be grouped into two basic classes:

1. Countertorque systems—plugging
2. Generating systems—dynamic and regenerative braking

Table 5—Control Size for Three Braking Methods

NEMA Size	Line Voltage	Recommended Maximum Horsepower Friction Brake & Std. Control	Plugging	DC Dynamic Braking
1	110	3	2	
	220	5	3	3
	440	7½	5	5
2	110	7½	5	
	220	15	10	15
	440	25	15	25
3	110	15	10	
	220	30	20	30
	440	50	30	50

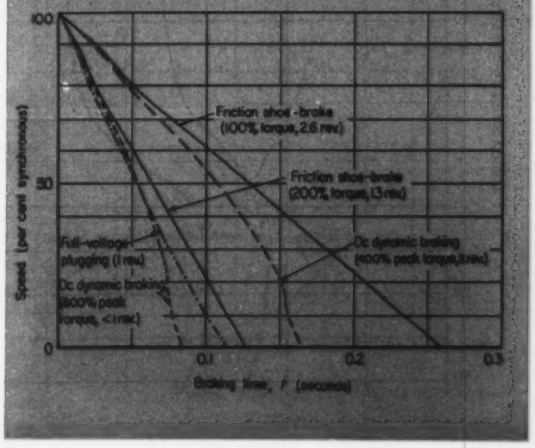
In the contertorque system, there is developed a torque which attempts to rotate the motor in a direction opposite to that existing at the time of the braking operation. If this countertorque is greater than any torques tending to keep the motor rotating, such as produced by an overhauling load, the motor will decelerate to a stop. At zero speed, this countertorque will attempt to accelerate the motor in the opposite direction unless it is removed. The important thing to remember in this type is that a braking torque exists whether the motor is rotating or not. This characteristic is useful in applications where "stalled tensions" such as on unwind reels is needed.

In the generating types, torques are developed in the motor because the motor is rotating. Two features differentiate the dynamic braking systems from the regenerative braking systems. First, regenerative braking occurs at motor speeds above the normal operating speed of the motor (synchronous speed in the case of an ac motor). Some force such as an overhauling load could cause the motor to overspeed. Dynamic braking occurs at motor speeds below the normal operating speed of the motor.

Second, in regenerative braking, the motor is always connected to the power system, and the power produced in braking is returned to the line. In dynamic braking, the energy produced in braking is dissipated either in a connected load or within the motor itself. Motor excitation of some sort must be provided, either from a power source or generated within the motor itself. Dynamic braking torques disappear at zero motor speed.

Regenerative braking is developed either by

Fig. 3—Comparison of various braking methods applied to a typical squirrel-cage motor. Braking torque is in per cent of full-load motor torque and revolutions marked with each curve are number of times motor shaft revolved after braking was initiated



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imposing a torque on the motor to cause it to speed up, or by changing the normal operating speed by reconnecting windings as in the case of a two-speed ac motor. When switching from high speed to low speed, regenerative braking takes place when the motor is connected for the low speed and is still rotating due to the momentum developed at the high speed. The regenerative braking action will tend to decelerate the motor quickly to the lower speed.

On some applications, such as high-inertia fans with multispeed motors, the effects of regenerative braking when changing from a high speed to a low speed may be undesirable. The braking effect may be so severe as to cause damage to the equipment.

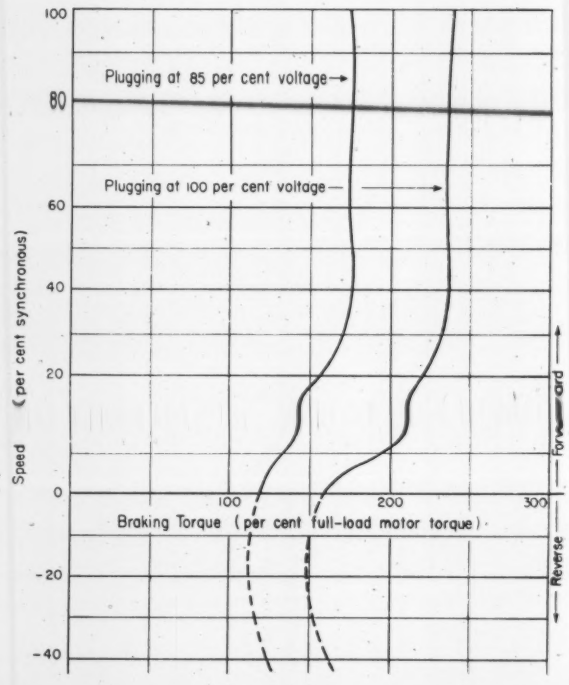
In general, the braking-currents developed in the motor must be considered when applying internal electric braking. Except for ac plugging, most current magnitudes are in the same order as those encountered in accelerating the motor. On dc motors, the current peaks during braking can be no higher than those the commutator can handle. A value of 150 per cent of full-load cur-

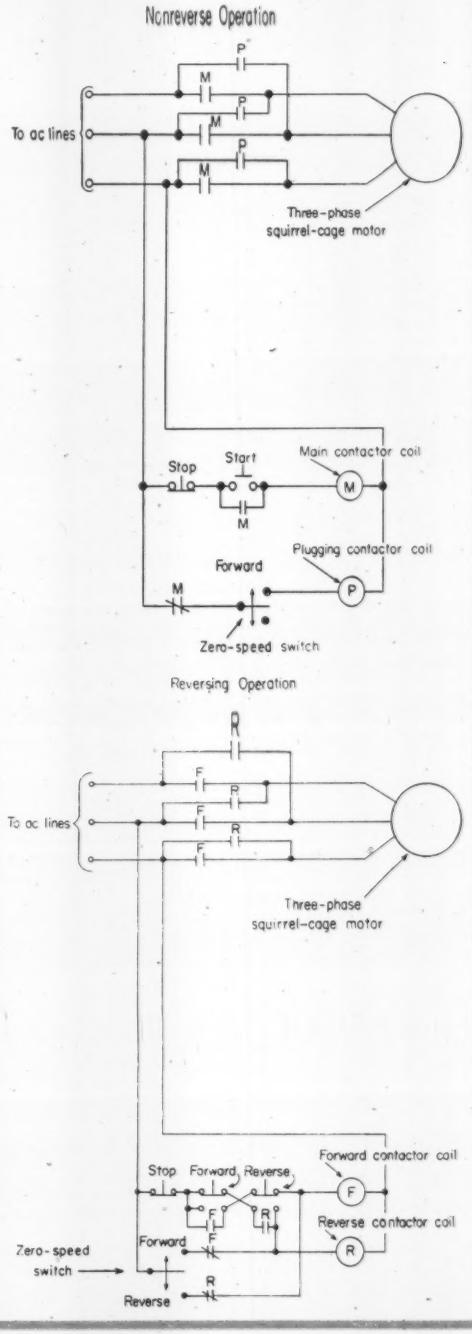
BRAKING BY PLUGGING AC AND DC MOTORS

Applicable Motor Types: Polyphase squirrel-cage, wound-rotor, and synchronous; dc shunt and series; universal; single-phase repulsion (special switching required).

Operation: Braking action is applied to motor by disconnecting and reconnecting motor connections to produce a countertorque on the armature (or rotor).

Characteristics: Motor must be de-energized when zero speed is reached otherwise it will accelerate in the reverse direction. Losses during plugging are high. For squirrel-cage motors losses are three times that for starting. This braking method is simple and fast-operating. Requires attention of operator, timer or zero-speed switch to turn off power to prevent reversal of rotation at zero speed. Electric power system must be capable of supplying peak plugging current required. Motor windings may require special bracing since braking action is severe unless limited by motor series resistors.





rent is a typical limit. Some motors can handle even more.

Except for force-ventilated motors, the heat-dissipation of a motor reduces as the motor speed reduces. Consequently, if a countertorque system or dynamic braking system is applied for some duration at reduced motor speeds, such as on unwind reels requiring tension, detailed information should be given to the motor manufacturer so that the motor will be designed to avoid overheating.

Of particular interest to the machine designer are the speed-braking torque characteristics. With some braking methods, such as dc dynamic braking, the retardation torques are produced more gently than with others such as plugging. While any one of several braking methods may provide the same stopping time, a severe braking method may not be the best one. High decelaration values may cause an upset on a glass bottle conveyor line, for example.

Dynamic braking by capacitor may be desirable where heavy braking action may be needed while still permitting a rolling action. Here the braking torque disappears at about one-third speed. This may be desirable on a machine where gear shifting must occur at a low speed and some momentum is still available to mesh the gears.

Many times the advantages of several braking methods are obtained by combining them as mentioned previously. On elevators, cranes, conveyors using dc motors, for example, shoe brakes are combined with regenerative and dynamic braking. On overspeeds, regenerative braking takes over whereas on power failure dynamic braking is applied if the field can be maintained. When speed has reduced to a low value where the dynamic braking is not effective, the shoe brakes are engaged. Applying these brakes at the low speed reduces the wear on the brake linings, too.

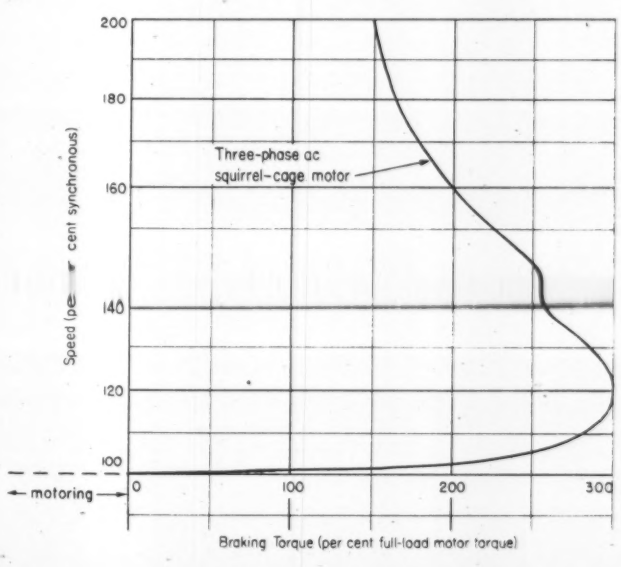
Braking Controls: Of course, control selection enters the picture where several systems are combined. In many cases where braking is introduced, the choice of braking may affect control size. *Table* 5 shows how the size of an ac linestarter must be derated when applying plugging. If a lathe is driven by a 5-hp 220-volt motor, a Size 1 reversing linestarter control would be inadequate for plugging service. A Size 2 reversing starter must be specified.

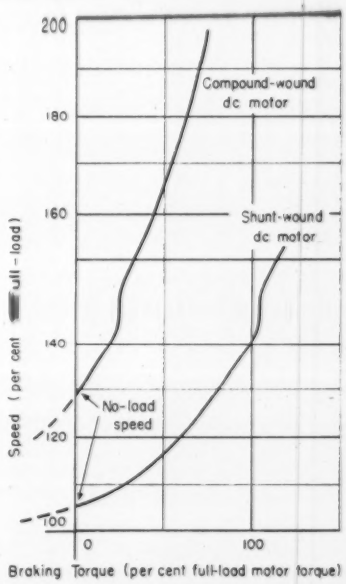
REGENERATIVE BRAKING OF AC AND DC MOTORS

Applicable Motor Types: All types.

Operation: Regenerative braking is similar to dynamic braking in that the motor acts as a generator, but in regenerative braking the motor is not disconnected from the line. It is loaded by feeding its generated power back into the line.

Characteristics: The retarding torque is high and motor losses are low. When braking is applied from twice synchronous speed to synchronous speed, the motor losses are approximately equal to those that occur during starting. Regenerative braking is of value for limiting the speed of overhauling loads or for positive slowdown from high speed to low speed on multi-speed or adjustable-speed motors. No extra equipment is required except for series-wound dc motors. Can be made effective with dc motors at reduced speeds by strengthening the motor field, i.e., by lowering the speed at which the motor will generate. Effective only with overhauling loads or positive slowdown. Useless as a means of stopping. Where dc motors must be made to regenerate at low speeds, the control becomes complicated and expensive. Motor may require special fields.



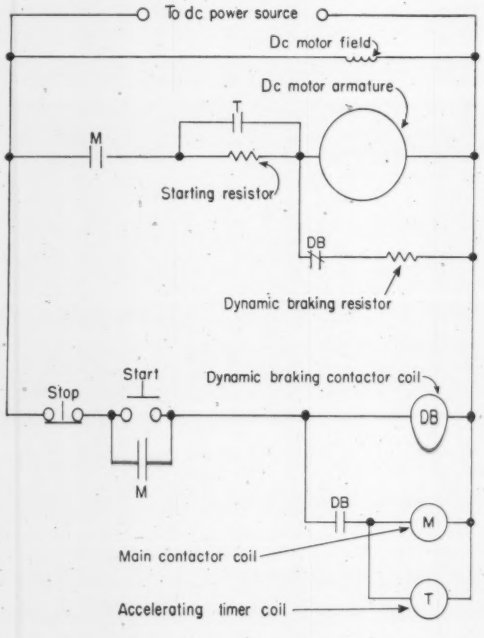


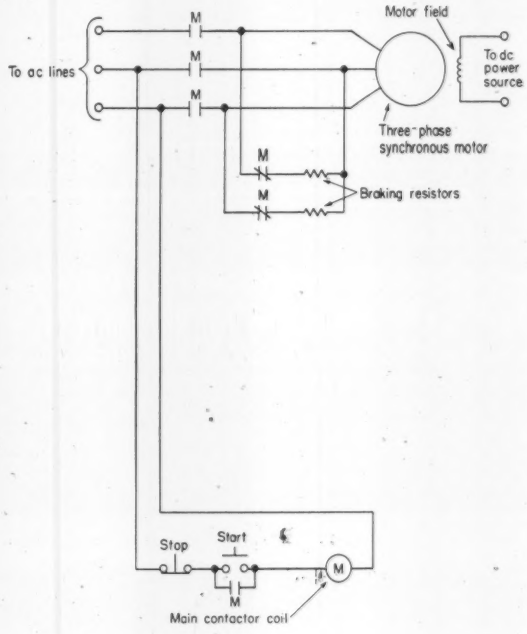
DYNAMIC BRAKING OF
. . . by Resistors

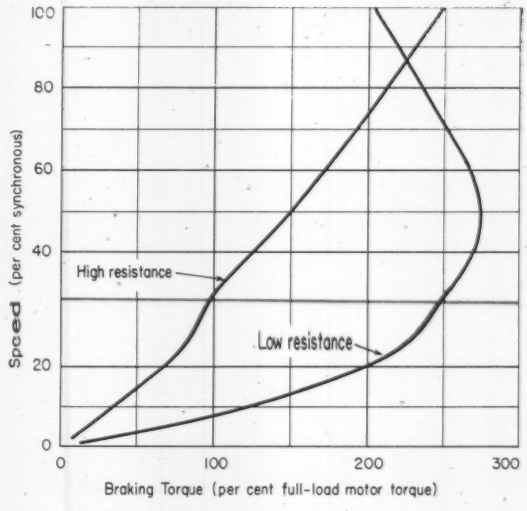
Applicable Motor Types: Most dc, universal and ac synchronous motors.

Operation: After being disconnected from the power supply, motor acts like a loaded generator and pumps current through a closed-resistance circuit or through part of its own winding. In all motors, some form of field excitation must be available. On dc motors, the field winding must be separately energized except permanent-magnet types. On synchronous motors, excitation is applied to the field winding.

Characteristics: Cannot reverse motor. No zero-speed switch or other antireversing device is required. This is a smooth, positive method of retardation, less severe than plugging. Braking torque is easily adjusted by varying either the dc excitation or the motor secondary load resistors. Requires a source of dc excitation during the braking period. Braking is not available if excitation source fails. Useless as a holding force after motor has come to rest and is deenergized.







In comparing first costs of braking methods, it is important to examine comparable braking results. In some horsepower ranges shoe-brake applications are approximately the same price as plugging where shoe-brake torques are applied at 100 per cent of the motor full-load torque and plugging is applied at full voltage. The graph in *Fig. 3* shows that full-voltage plugging will stop a motor in about half the time that a 100 per cent torque friction shoe-brake would. To obtain the same stopping time as plugging, the shoe-brake would have to be twice the capacity, which would make plugging lower in first cost. However, if reduced-voltage plugging were applied to make the plugging time comparable to the 100 per cent torque shoe-brake, the additional control would cause the plugging system to become more expensive than the shoe-brake.

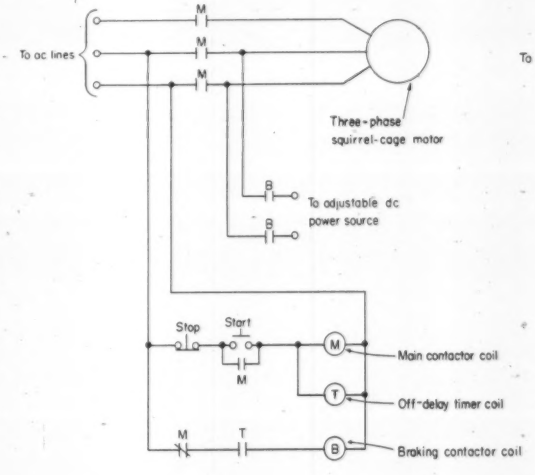
AC AND DC MOTORS
. . . by DC Excitation

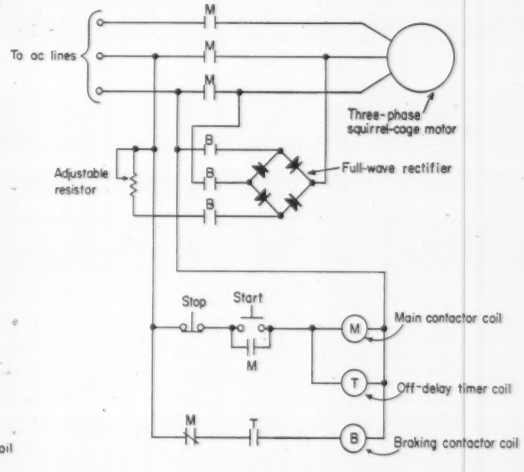
Applicable Motor Types: Most ac single-phase types, three phase squirrel-cage and wound rotor.

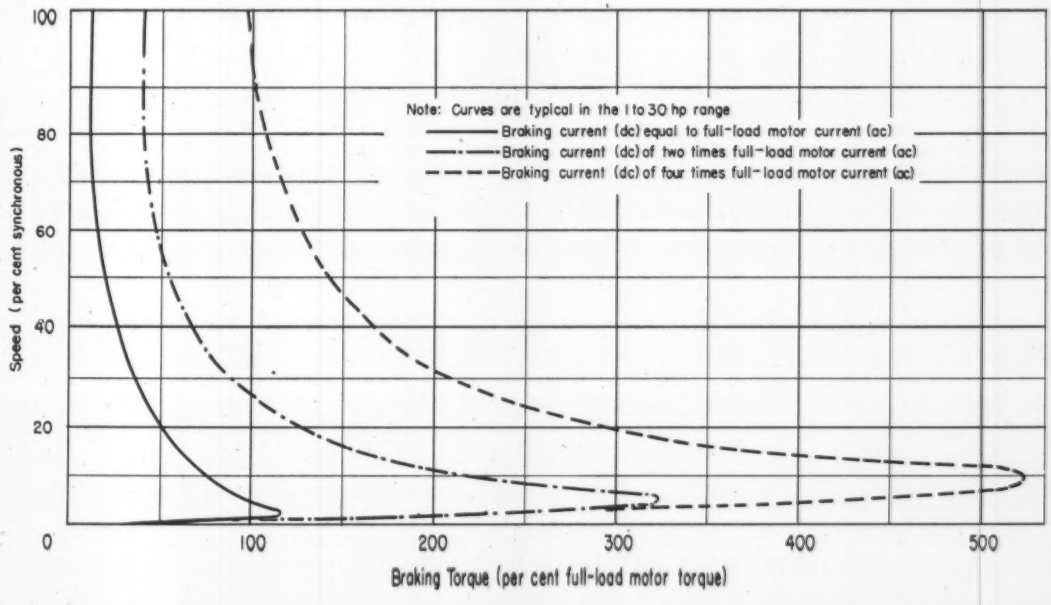
Operation: In this form of braking dc is applied to one phase of a squirrel-cage or wound-rotor motor after the removal of the ac power. When the stop button is pressed, the braking contactor is energized to connect the dc power to one phase of the motor primary winding. The motor then acts like a generator and is loaded by the induced current flowing through the rotor winding.

Characteristics: This method of braking provides high maximum torque with low losses. The losses in braking from full speed to zero are approximately the same as losses developed during starting. The torque obtained falls off rapidly at high speeds for motors of normal slip. If a rapid stop is to be obtained, it is necessary to use a high dc exciting current. The value of dc used is usually two to three times full-load current, but may be higher for quick stopping. The use of high-slip motors results in much higher average braking torque for a given value or dc excitation. The dc excitation is usually provided by rectified ac. A time-delay relay is normally required to remove the dc after motor comes to a stop.

Typical Applications: Radial drills, vertical presses, lathes, conveyors, can-making machines, milk-bottling and cartoning machines, textile machines, dressing reels, spinning frames and looms.







DYNAMIC BRAKING OF

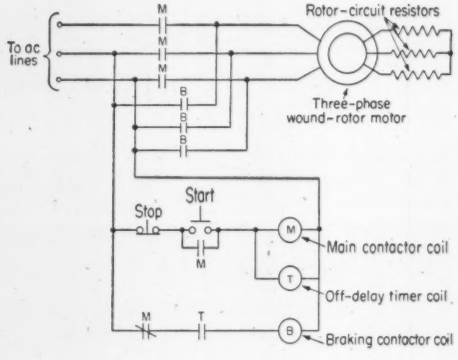
. . . by AC Excitation

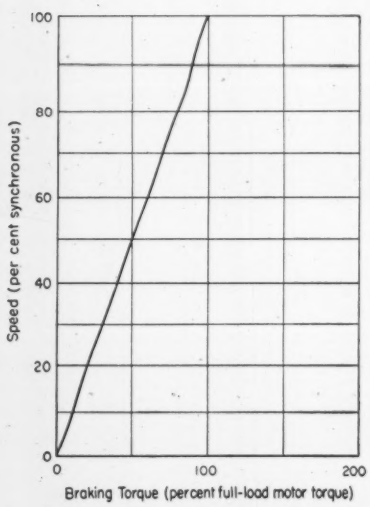
Applicable Motor Types: Three-phase wound rotor.

Operation: When used in crane controls and hoists, this braking method is usually referred to as ac dynamic lowering. To obtain the retarding effect, single-phase ac is placed across one phase of motor while another phase is shorted by a contactor. Such a connection produces a pulsating magnetic field in place of the usual revolving field. No torque is developed by the motor to drive the load. As the rotor is turned in this pulsating field, current is generated and flows through the rotor winding and its external resistance. This circuit produces an electrical retardation of the overhauling load. Different retarding torques can be obtained by using different values of resistance in the rotor circuit.

Characteristics: Braking method is simple, inexpensive, quite suitable for overhauling loads. Heating effect may necessitate an oversize motor. Braking action reduces with speed and is zero at standstill. Must have single-phase ac power available for braking.

Typical Applications: Crane controls, hoists.

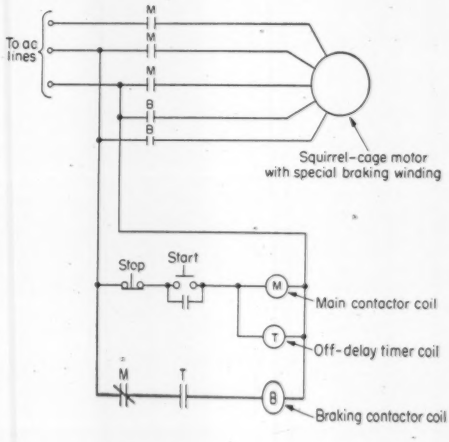


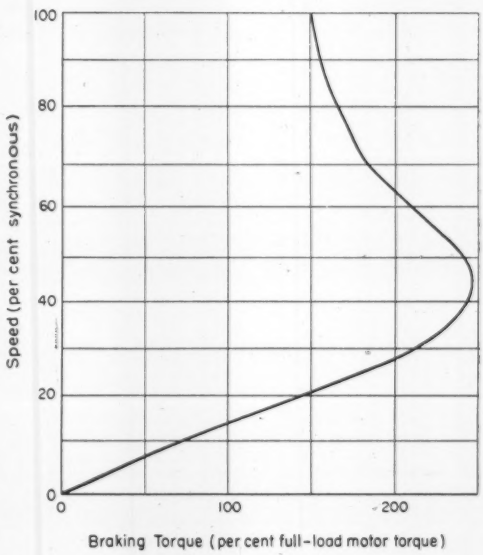


Applicable Motor Types: Three-phase squirrel-cage with special windings.

Operation: A special brake winding consisting of a multipolar two-phase winding is superimposed on a standard stator winding of a squirrel-cage motor and is designed to be non-inductively coupled to main motor winding. During braking, one phase of the brake winding is shorted on itself and the other phase is energized from the ac line.

Characteristics: Requires power from the line during braking. Motor must be rotating to provide braking action. Braking windings are usually rated for intermittent duty. Braking action is similar to dynamic braking by dc excitation which is smooth.





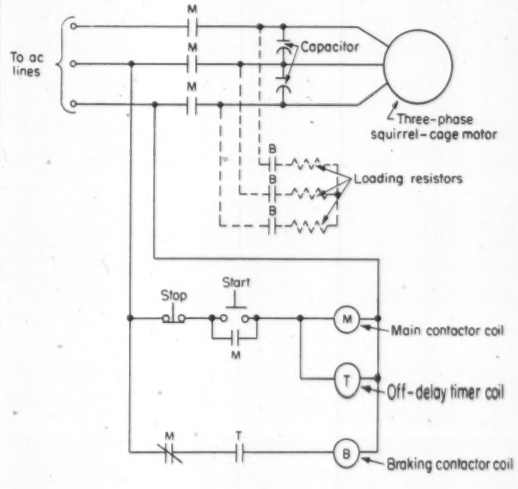
POLYPHASE AC MOTORS

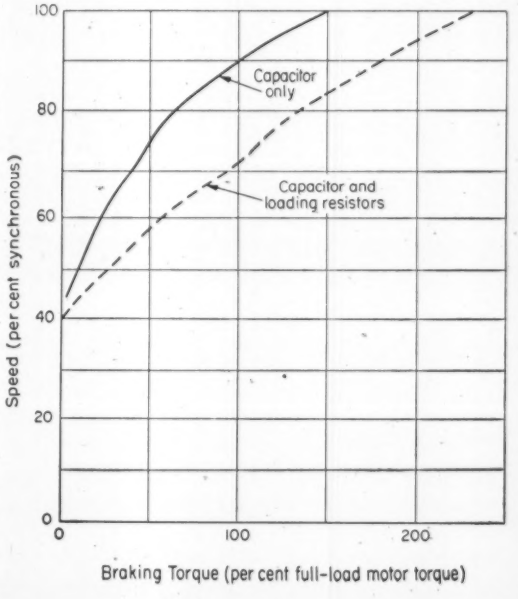
. . . by Capacitor-Resistance Circuits

Applicable Motor Types: Three-phase squirrel-cage.

Operation: A capacitor connected across the motor terminals supplies a leading current which serves as excitation to provide dynamic braking when the run contactor opens. Braking torque increased by proper use of loading resistors in addition to the capacitors.

Characteristics: This braking method provides power factor correction while the motor is running. Braking action is independent of voltage failure of power supply. Very little maintenance is required. Braking action disappears at about one-third motor speed. Capacitors for sufficient braking usually provide a leading power factor to the system.

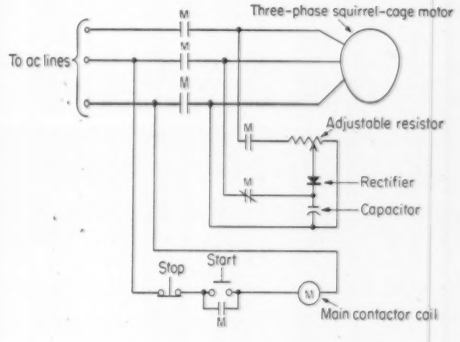


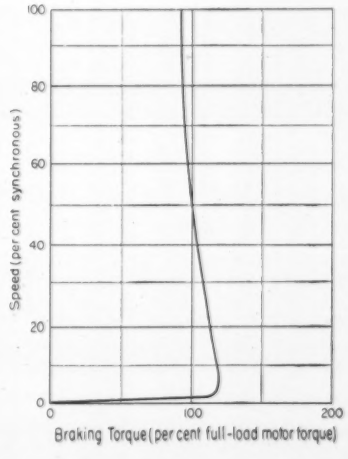


Applicable Motor Types: Three-phase squirrel-cage.

Operation: The capacitor is charged through the rectifier circuit while the motor is running. For stopping, the main-contactor interlock connects the capacitor to the motor and it discharges dc current through the winding to give effective braking. This system differs from the other capacitor braking method in that dc power discharging from the capacitor is applied to the motor winding. This method is contrasted to dynamic braking by dc excitation where a constant dc voltage is applied and braking torque actually increases as speed decreases to about 10 to 20 per cent of normal speed. The dc capacitor discharge method starts with maximum voltage at maximum speed which then decreases with speed to give essentially straight-line braking torque. The dc power flows only until the capacitor is discharged. By proper proportioning of capacitor values to motor and load characteristics, time constants can be obtained so that the discharge time equals the deceleration time.

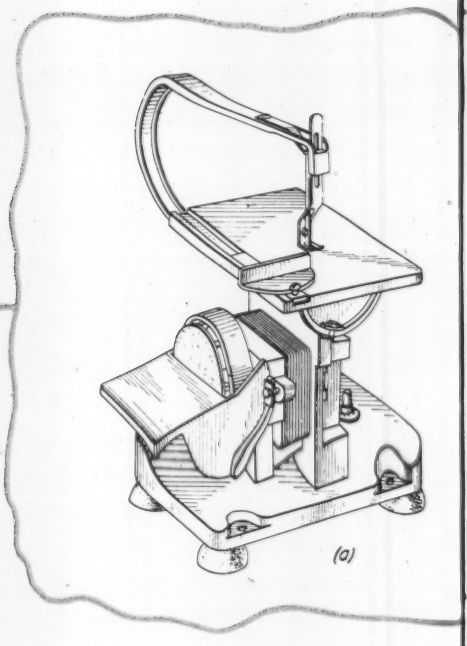
Characteristics: No electric power is required during braking because energy stored in capacitor supplies braking power. Very large capacitors are required. For example, a ½-horsepower, 440-volt, 1800-rpm motor requires 2500-microfarad, 250-volt capacitors for a stopping time of about 1 second.





Fundamentals of

Design Patents



A SOMETIMES misunderstood form of legal protection, the design patent, has long been an important part of the patent law. As defined and interpreted by the courts, it is closely similar to the mechanical patent in many features although its function is somewhat different. Basically, the distinction lies in the legal interpretation of the term "design" which in the language of patent law refers only to outward physical appearance. Here, as defined by the courts, are the essential features of a valid design patent.

Basic Distinction

A recent action before the Federal Court of Appeals for the infringement of a design patent on an electrically operated saw emphasized the fundamental distinction between mechanical and design patents. The three important features of the former are invention, novelty and utility, and of the latter, invention, novelty and beauty.

The usual defense of infringement suits was interposed in this action; that the design patent on which the claim of infringement rested was not a valid patent. In its decision that this design patent was invalid the court said, "As in the case of mechanical patents the design must be the product of inventive faculty. In the one must appear creative novelty and utility, in the other creative originality in artistry. It is not enough to say that the design is new and pleasing to the eye. Its conception must require that exceptional talent which is beyond the skill of the ordinary designer. **It must be kept in mind that the exercise of the inventive genius, so essential to validity, relates only to the appearance of the article and its aesthetic appeal. It is artistic creativeness which the statute awards.**"

In explanation of these basic rules for patents of this character, the court added, "Just as it is not enough to say that a design is pleasing in appearance, neither is it sufficient simply to say that no prior design is 'like' the one in suit. That a design may be distinguished from those found in the prior art does not import the required novelty and ornamentation.

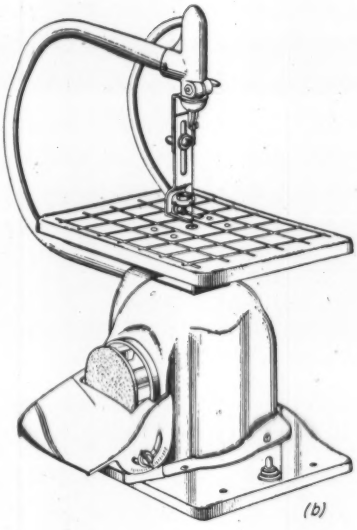
"The design may be tested by its overall aesthetic affect and its artistic appeal, if there be any, must represent a step which has required inventive genius beyond the prior art.

"However," concluded the court, "the ultimate question here is whether the design achieves the high level of creative artistry demanded by the statute."

Statute Provisions

The present statute, which was enacted in 1952, reads, **"Whoever invents any new, original and ornamental design for an article of manufacture, may obtain a patent therefor** subject to the conditions and requirements of this title."

The law from which this present statute is derived was originally enacted in 1842, " . . . any citizen or citizens . . . who by his, her or their own industry, genius, efforts and expense may have invented or produced any new and original design for a manufacture, whether of metal or other material . . . or any new and original shape or configuration of any article of manufacture . . . who shall desire to obtain an exclusive property or right therein to make, use and sell and vend the same,



Similar patented jigsaw designs which were the subject of a patent infringement action. Design at *a*, on which claim of infringement rested, was declared invalid by the Federal Court of Appeals

By Albert Woodruff Gray

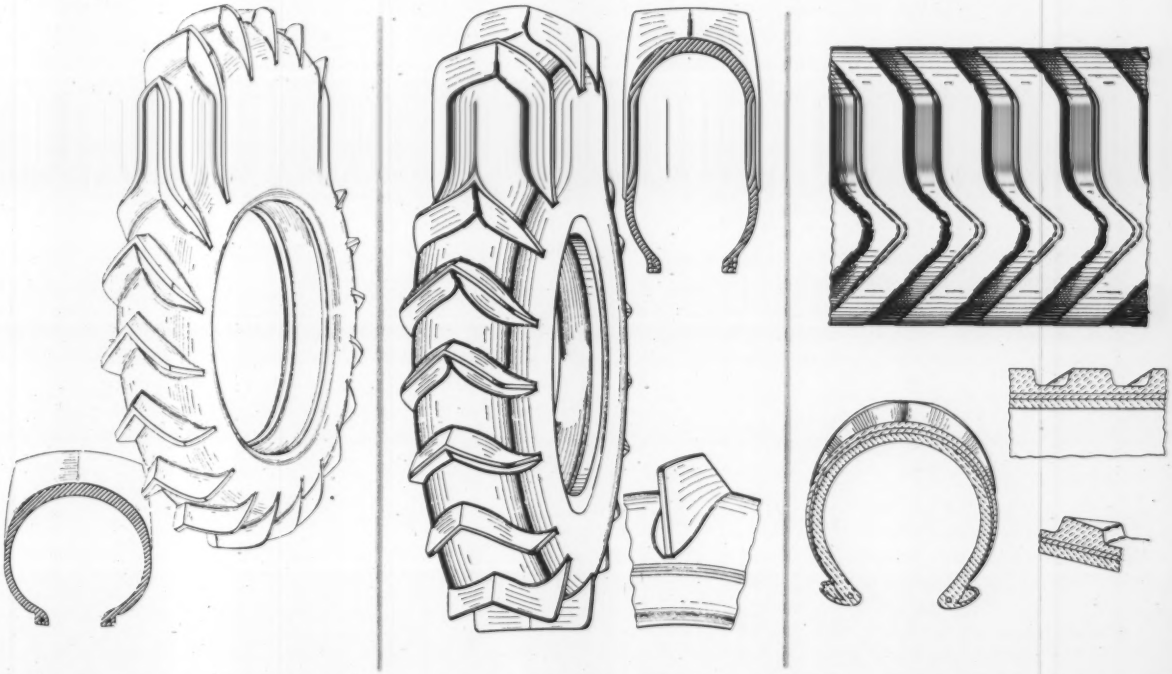
Jackson Heights, L. I.
New York

may make application in writing to the Commissioner of Patents."

Shortly after this law was enacted, a manufacturer of silverware was granted a patent on a design of tablespoons and forks. Later, another manufacturer secured a patent for a similar design which the first manufacturer contended was an infringement of the patent which had already been issued. When the action for infringement brought by the first manufacturer came before the United States Supreme Court for decision, that court laid down the fundamental principles that still govern the validity of patents of the designs of machines or, for that matter, any other manufactured product.

"The thing invented or produced for which a pat-

Mechanical patents on three tire tread designs that were cited as authority by the Patent Office in refusing a design patent on an aircraft tire with similar ridges



ent is given, is that which gives a peculiar or distinctive appearance to the manufacture or article to which it may be applied," said that court.

"The law manifestly contemplates that giving certain new and original appearances to a manufactured article may enhance its salability, may enlarge the demand for it and may be a meritorious service to the public. It therefore purposes to secure for a limited time to the ingenious producer of those appearances the advantages flowing from them.

"Manifestly the mode in which those appearances are produced has very little if anything to do with giving increased salableness to the article. It is the appearance itself which attracts attention and calls out favor or dislike. **It is the appearance therefore, that constitutes mainly, if nor entirely, the contribution to the public which the law deems worthy of recompense.** The appearance may be the result of configuration or of ornament alone, or of both conjointly, but in whatever way produced, it is the new thing or product which the patent law regards."

Legal Definition

The word "design," continually recurring in design patent law, was defined over half a century ago by a Federal court with a scientific precision that has been scrupulously observed and retained.

According to the court in that instance, **"'Design,' in view of the patent law, is that characteristic of a physical substance which, by means of lines, images, configuration and the like, taken as a whole, make an impression through the eye upon the minds of the observer.** The essence of a design resides, not in the elements of individuality nor in their methods of arrangement, but in the tout ensemble—in that indefinable whole that awakens some sensation in the observer's mind. Impressions thus imparted may be complex or simple, in one a mingled impression of gracefulness and strength, in another the impression of strength alone. But whatever the impression, there is attached in the mind of the observer to the object observed, a sense of uniqueness and character."

Test of Patentability

An application made a few years ago for a design patent for a "pressure fluid medium container" was rejected by the Patent Office for lack of invention. The applicant appealed to the United States Court of Customs and Patent Appeals.

That design comprised an elongated cylinder having a short neck at one end and a closed bottom at the other, and, according to the description in the patent application, "Having at the bottom a series of circumferentially spaced protuberances radiating from a central substantially circular area."

In his description of this container, the applicant for the patent stated, "Vessels of this type are used to store gases, such as carbon dioxide, under high pressure as liquids and while such vessels have been used commercially for decades there has been no attempt to improve their ornamental appearance."

In support of his application, the inventor insisted that the design for the bottom of the cylinder permitted the vessel to stand on end and greatly enhanced the ornamental appearance not only of the bottom of the container but of the overall unit.

The Patent Office Examiner rejected the application as a patent had already been granted for the design of a cylindrical housing for a microphone with circumferentially spaced protuberances radiating from a central area. The use of similar protuberances on a like surface of a different article would not be inventive in an ornamental design sense.

From this ruling the inventor appealed, and the Federal Court of Appeals, in sustaining this ruling of the Patent Office, said, **"In design patent cases the question of utility is not involved. The mere fact that the design sought to be patented may involve some mechanical or utilitarian function, however, will not render it unpatentable but the patentability of a design may not be predicated on utility.**

"It is therefore immaterial that applicant's vessel provides a bottom on which the vessel can stand or that the design of the cylinder bottom does not reduce its ability to withstand high internal pressures. The only issue before us is whether the inventor has produced through the exercise of the inventive faculty, a new, original and ornamental design for the article of manufacture.

"A design to be patentable must not only be new, original and ornamental but it must result from the exercise of the inventive faculty as well. The fourth element, exercise of inventive faculty, is the element determining the patentability. It is said to defy definition and its determination rests as a subject standard in the mind of the judge, considered as an average observer."

This decision was followed as an authority by the United States Court of Customs and Patent Appeals a few months later. Its decision concerned an application for a design patent on an aircraft tire which was described by the Patent Office in its refusal of the patent as, "A tire tread made up of a series of V-shaped ridges, arranged in the manner of chevrons with the apices of the angles of the ridges lying on the median plane of the tire."

"We think the applicant in his contentions here disregards the necessity for the exercise of the in-

ventive faculties in producing a patentable design," said the court.

"Carried to their logical conculsion the applicant's contentions are to the effect that one must be regarded as a design inventor if he produces a design which has a pleasing effect and which differs in appearance from any prior production irrespective of any other consideration.

"The design patent law grants a limited monopoly to a design inventor. The purpose of the enactment obviously was to stimulate the exercise of the inventive faculty in the improvement of the appearance of articles of manufacture. **Invention consists in something more than good draftsmanship and extended research for new appearances.**

"To grant patent monopolies like this would in our opinion necessarily hamper and obstruct manufacturers in the development of their business without promoting the purposes for which the design patent law was enacted."

Another decision of the Supreme Court rendered over sixty years ago has served as a supplement to the outline of this law which was made by the court in the earlier action involving the infringement of the silverware design patent discussed previously. Suit had been brought in this instance against a firm for the infringement of a patented saddle design. The trial court had held, in spite of what it termed a substantial sameness in the designs which would deceive the eye of the ordinary purchaser, that, "A mechanic may take the legs of one stove and the cap of another and the door of another and make a new design which has no element of invention, but it does not follow that the result of the thought of the mechanic who has fused together the two diverse shapes which were made upon different principles, so that new lines and curves and a harmonious whole are produced, which possesses a new grace and which has a utility resultant from the new shape, exhibits no invention."

That decision, however, was reversed by the Supreme Court, which said, **"The law applicable to design patents does not materially differ from that in cases of mechanical patents. To entitle a party to the benefit of the act in every case there must be originality and the exercise of the inventive faculty.** In the one there must be novelty and utility, in the other originality and beauty. Mere mechanical skill is insufficient. There must be something akin to genius—an effort of the brain as well as the hand. **The adoption of old devices and forms to new purposes, however convenient, useful or beautiful they may be in their new role, is not invention.**

"The exercise of the inventive or originative faculty is required and a person cannot be permitted to select an existing form and simply put it to a new use any more than he can be permitted to take a patent for a mere double use of a machine. If however, the selection and adoption of an existing form is more than the exercise of the imitative faculty and the result is in effect a new creation, the design may be patentable."

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1. Burgess Vibrocrafters Inc. v. Atkins Industries Inc., 204 F.2d 311, May 15, 1953.
2. 35 U.S.C.A., Sec. 171.
3. 5 Statutes at Large 543 (1842).
4. Gorham Co. v. White, 14 Wall. (U. S.) 511, (1871).
5. Pelouze Scale & Mfg. Co. v. American Cutlery Co., 102 Fed. 916, May 31, 1900.
6. Application of Jabour, 182 Fed. 2d 213, May 9, 1950.
7. Application of Bigelow, 194 Fed. 2d 545, Jan. 29, 1952.
8. Whitman Saddle Co. v. Smith, 148 U. S. 674, rev'g. 38 Fed. 414.

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industrial design Ideas

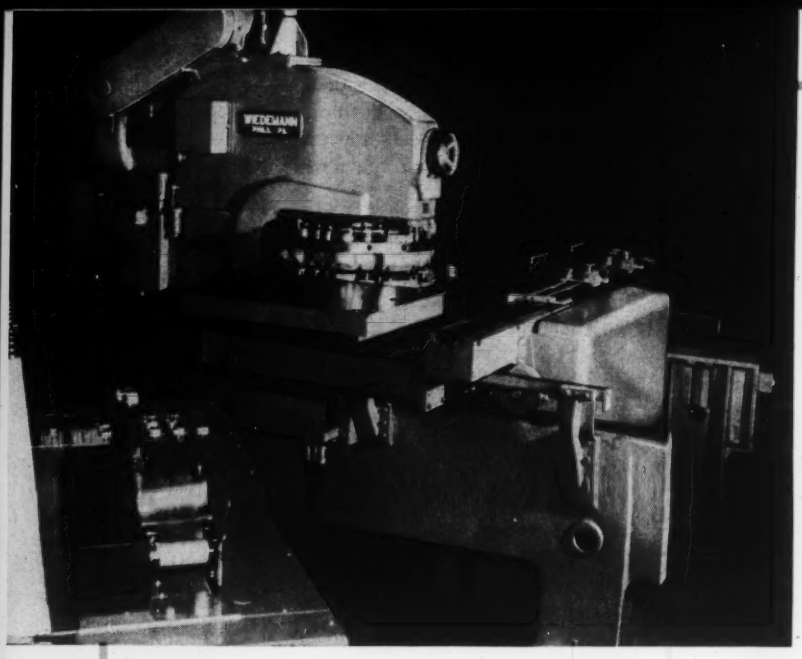
paper dolls

MANY engineers have trouble designing fabricated assemblies to meet the standard requirements of maximum rigidity at lowest cost. With only a preliminary layout in hand, it's smart to make a small scale paper model of your brain-child. The boys may kid you about cutting out paper dolls, but I'll guarantee that your "paper work" will pay off.

Here's how: you can only bend paper in one direction, just the same as sheet metal (without expensive dies) . . . you're apt to take a bold approach and eliminate a lot of small gussets and unnecessary parts because you're lazy and your fingers will get in the way . . . you will probably put in a few bends so that one piece takes the place of several that you put in the drawing . . . you will use some of your paper scraps for small sections, just as the fabricator will do . . . if you keep paper thickness closely to scale, you will get an excellent idea of the rigidity of your assembly . . . you can easily estimate final weight by weighing the model and converting to sheet-metal weight . . . your estimator will appreciate the simplicity of figuring final costs.

I'll also guarantee your final model will be considerably changed from your original layout *and will be stronger, cheaper and better looking.* (For a start, try using approximately 1/16-inch thick artists' illustration board.)

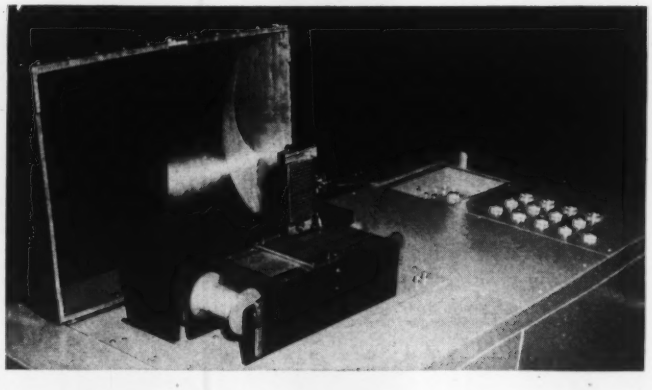
—Clift



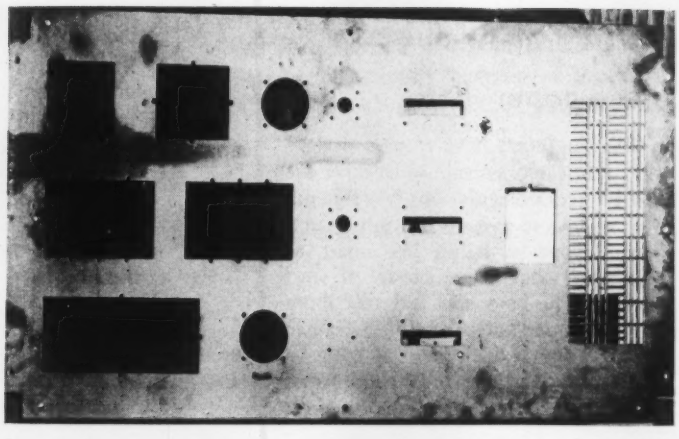
Punch Press Is Tape Controlled

COMPLETELY automatic location and piercing of holes without operator attention is claimed for a new turret punch press. Capacity is 40 tons; throat depth is 33 inches. Holes as large as 6 inches square can be punched in sheet steel. A tape-fed programming unit controls all functions, including positioning, turret rotation and tripping the press. The machine is made by Wiedemann Machine Co.

Programming unit is electromechanical and employs perforated vinyl tape. The special vinyl tape is unaffected by the oils and greases with which it may come in contact. Changes in a part being produced may be made easily by covering a portion of the tape with a gummed sticker and repunching holes. Tapes may be stored and reused at a later date. Only setup necessary for the most complex part is the attachment of the proper tooling to the press.



Typical panel was produced by the new press in 17 minutes. Estimates of time required by other methods vary from 5 to 20 hours. Three panels are bolted together here to illustrate accuracy of the method.



Contemporary Design

MOHR'S CIRCLES

for a three-dimensional state of stress

By M. Mark
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Raytheon Mfg. Co.
Newton, Mass.

USE OF Mohr's circle to represent a two-dimensional state of stress is common.[1] The application to a three-dimensional state of stress is not as widely known, but the circles represent the more general condition, of which the two-dimensional state is a special case. For three dimensional stress, it is simpler in some cases to use this graphical method than to solve the analytical equations, the resultant picture being very helpful in visualizing the state of stress at a point. These diagrams were originated by Otto Mohr[2] and graphically present the relationship between the principal stresses at a point and the shearing and normal stresses at the same point on planes inclined to the planes of the principal stresses. Mohr's circles are briefly developed here in the manner of Westergaard.[3]

Consider a state of stress at some point in a solid. Three directions exist, perpendicular to each other, along which normal stresses act unaccompanied by shearing stress. These normal stresses are called principal stresses; two of them represent the largest and the smallest of all the normal stresses at the given point. Let the origin of an orthogonal co-ordinate system be the point under consideration and let the principal stresses σ_x, σ_y, and σ_z be aligned with the co-ordinate axes x, y, and z, *Fig.* 1. For a plane through the point whose normal makes angles θ_x, θ_y, and θ_z with the x, y, and z co-ordinate axes, there exist a normal stress σ, a shearing stress τ, and a resultant stress s, *Fig.* 2, on this plane related by

$$s^2 = \sigma^2 + \tau^2 \quad \ldots\ldots (1)$$

In addition, σ and τ are related to the principal stresses σ_x, σ_y, and σ_z at the point by the following relations:

$$s^2 = (\sigma_x \cos \theta_x)^2 + (\sigma_y \cos \theta_y)^2 + (\sigma_z \cos \theta_z)^2 \quad \ldots (2)$$

$$\sigma = \sigma_x \cos^2 \theta_x + \sigma_y \cos^2 \theta_y + \sigma_z \cos^2 \theta_z \quad \ldots\ldots (3)$$

If the σ-τ graph, *Fig.* 3, is introduced, the equation of a circle whose center lies at a distance $\frac{1}{2}a$ on the σ-axis is

$$\sigma^2 - a\sigma + \tau^2 = b \quad \ldots\ldots (4)$$

where a and b are arbitrary constants. Equations 1, 2, and 3 allow σ and τ to be represented in the

[1]References are tabulated at end of article.

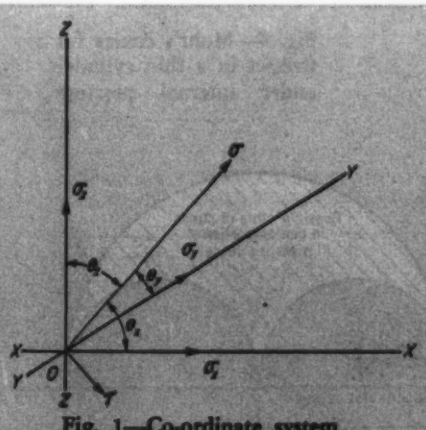

Fig. 1—Co-ordinate system and stresses for three-dimensional stress at point *O*

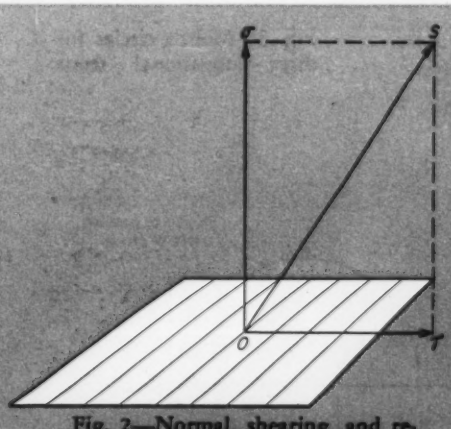

Fig. 2—Normal, shearing, and resultant stresses on a plane through point *O* in a body under stress

form of Equation 4 on the σ-τ graph. The necessary relationship is found by combining the foregoing equations. Substituting Equations 1, 2, and 3 into Equation 4, eliminating σ and τ,

$$(\sigma_x \cos\theta_x)^2 + (\sigma_y \cos\theta_y)^2 + (\sigma_z \cos\theta_z)^2 = a\cos^2\theta_x\,\sigma_x + a\cos^2\theta_y\,\sigma_y + a\cos^2\theta_z\,\sigma_z + b \quad (5)$$

The equation for the angles of the normal to the plane on which σ and τ act is

$$\cos^2\theta_x + \cos^2\theta_y + \cos^2\theta_z = 1 \quad (6)$$

Equation 6 represents a sphere of unit radius in the co-ordinate system of *Fig.* 1. The intersections of the sphere of Equation 6 and the surface of Equation 5 which result in circles are Mohr's circles. They can be represented in the form of Equation 4 on the σ-τ graph. Possible combinations of σ and τ are then represented by any point lying on one of these circles.

For two cases the intersections become circles. The first is where Equation 5 is an ellipsoid of revolution partially inside and outside the unit sphere of Equation 6. The intersections consist of two parallel circles. The second case is where the surface of Equation 5 is an ellipsoid tangent to the unit sphere at opposite poles and partially inside and outside the sphere. The intersections are then meridian circles. Equation 5 becomes an ellipsoid of revolution when

$$\sigma_x(\sigma_x - a) = \sigma_y(\sigma_y - a) \quad (7)$$

Then from Equation 7

$$a = \sigma_x + \sigma_y \quad (8)$$

A similar relation can exist between σ_x and σ_z, or σ_y and σ_z. Therefore, as the center of the circle is located along the σ-axis at $\frac{1}{2}a$, from Equation 8 the centers of the circles of Equation 4 that correspond to the first case lie midway between the points on the σ-τ graph representing the principal stresses. The limiting curves are represented by *A*, *B*, and *C*, *Fig.* 3, which are determined by the semicircles passing through the points representing the principal stresses. Other circular arcs corresponding to this case (arcs of parallel circles of intersection) would be shown similar to *D*, *Fig.* 3, lying within the region enclosed by the semicircles *A*, *B*, and *C*. For the second case where the intersection is a meridian, the circular arc would appear as *E*, *Fig.* 3.

These circles representing the two types of intersections are Mohr's circles. Any single circle is Mohr's circle for a plane state of stress. Within the bounds of the three semicircles these circles represent the three-dimensional state of stress at a point. With the principal stresses given, the three limiting semicircles can be drawn (similar to *A*, *B*, and *C*, *Fig.* 3) and the state of stress graphically represented by the region bounded by the three semicircles (the hatched area of *Fig.* 3). All possible combinations of σ and τ must then lie within this region. It can be seen that the maximum shearing stress is equal to the radius of the largest semicircle.

For the two-dimensional state of stress, the three limiting semicircles still exist, but two of them will pass through the origin. For example, consider the case of a thin cylinder of diameter d and wall thickness t under internal pressure p. The principal stresses in the central portion of the cylinder are the hoop stress $pd/2t$ and the longitudinal stress $pd/4t$ both tensile (the third principal stress is zero). In this case Mohr's circles would appear as in *Fig.* 4, and the maximum shear stress can be seen to be equal to one-half the hoop stress.

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2. O. Mohr—*Abhandlungen aus dem Gebiete der Technischen Mechanik*, Second Edition.
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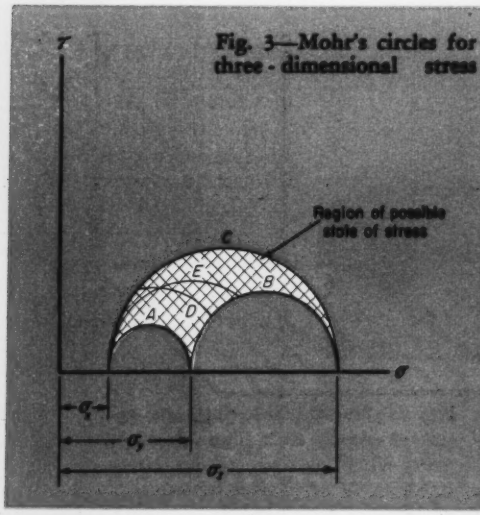

Fig. 3—Mohr's circles for three-dimensional stress

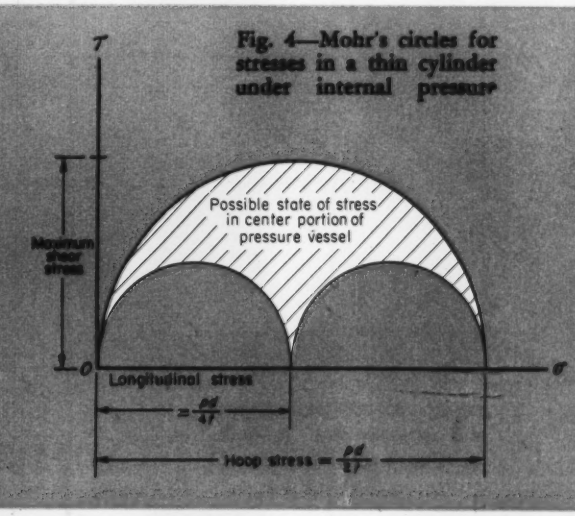

Fig. 4—Mohr's circles for stresses in a thin cylinder under internal pressure

PRODUCTION
Modern Practices in Manufacture
AND
DESIGN

Design Techniques for Drawn Parts

By Federico Strasser
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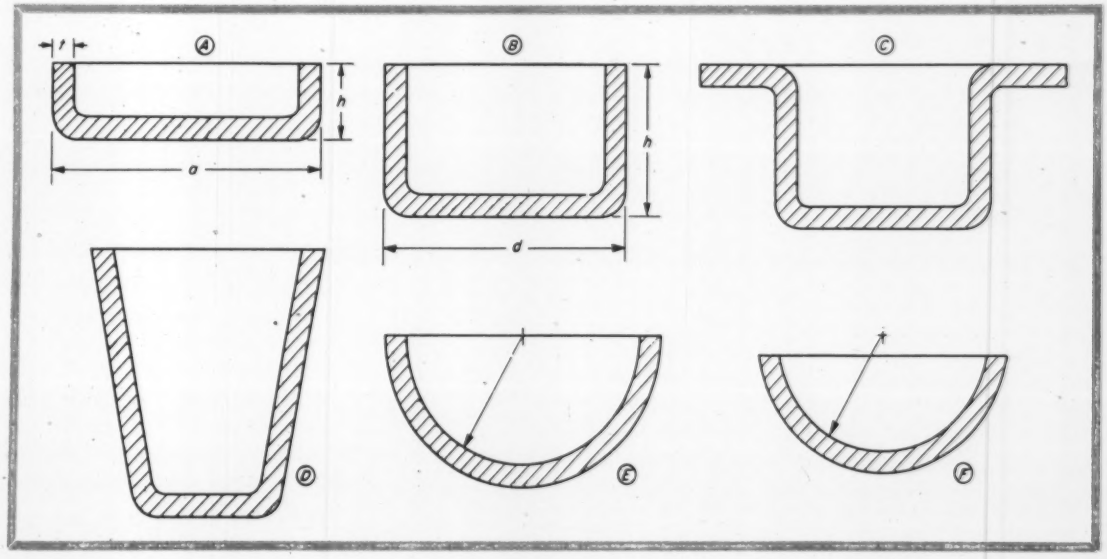
ANY MACHINE component must be designed to fit the manufacturing process producing it. If drawing is selected, the designer should be thoroughly familiar with press-working techniques to avoid parts that are difficult and expensive to make. It must be borne in mind that tooling for drawing is rather expensive, so that the process is usually considered economical only when comparatively large production quantities are involved. Also liberal tolerances are more desirable, and the material must be rather thick and ductile. A number of design shapes are possible, some being more suitable than others for drawing. Here, several drawn-part shapes are discussed along with several useful design suggestions which should be a guide to the most satisfactory and economical drawn components.

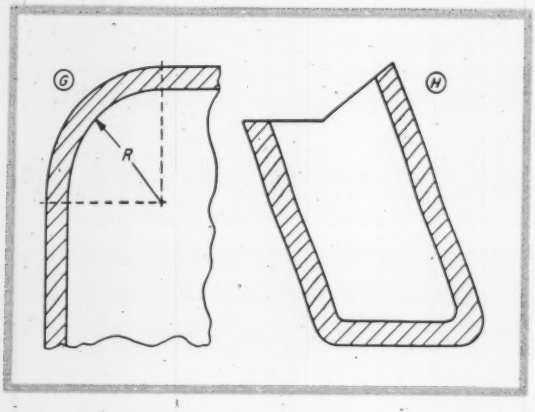
Cylindrical Shells: Since more than 95 per cent of all drawn workpieces are cylindrical in shape, this form of shells will be discussed first.

Drawing tools are comparatively expensive. This is because the drawing operation requires a few more press-tool members than ordinary cutting dies. These extra die-members are required because of the tendency of the metal to form wrinkles during the transformation from a flat blank into a shell. In order to avoid the formation of wrinkles, blankholder equipment must be used. However, there are cases where blankholder equipment is not necessary. This happens when the drawing depth is comparatively shallow and the stock is rather thick in relation to shell diameter. Maximum shell heights which can be drawn without a blankholder depend on many factors. However, shells can be drawn without blankholder when shell height is below 5 to 10 per cent of shell diameter, *Fig. A*. Lower values apply to higher thickness-to-diameter ratios ($h = 0.05d$ for $t{:}d \approx 1{:}300$) and the higher values for a low $t{:}d$ ratio ($h = 0.10d$ for $t{:}d \approx 1{:}150$).

Of course, it is possible to use plain drawing dies without a blankholder only for very shallow draw depths. Usually, the height of the drawn shell is considerably greater than the allowable 5 to 10 per cent, *Fig. B*. But shell depth should be held as low as possible to minimize drawing difficulties and therefore waste (failures) which determine final production costs.

In addition, the relationship between draw depth and shell diameter has a direct influence upon tool costs. In fact, it is not possible to draw a





shell directly from a flat disk (blank) if the ratio between shell diameter and depth is too great. The maximum permissible direct draw (with ordinary drawing dies equipped with blankholder) depends on a series of factors: ductility of stock, thickness, temper, surface finish conditions, construction of the tool, type of blankholder equipment, drawing speed, lubrication, etc. Consequently, there cannot be strict and formal rules set up because of the variability of the several determining factors. However, it is good practice not to drop below 1:1.7 to 1:2.3 for $h:d$ ratios in case of ordinary spring-actuated blankholders, whereas a value of 1:1 may be all right in case of hydraulic or pneumatic cushions or double-acting presses.

When proportions between shell height and diameter exceed these given limits, then shells must be produced in several passes (multiple-pass drawing). Amount of reduction between each redrawing is a matter of opinion and personal judgment, which varies greatly. At any rate, it seems that a 20 per cent diameter reduction is a good average.

Deepdrawing is expensive because of costs in tooling and labor of the drawing and redrawing operations. Also, since the metal work hardens, the shells must often be annealed between operations in order to relieve internal strains, thus restoring the original ductility. This further increases manufacturing costs.

Cylindrical Shells with Flanges: Drawn shells having flanges, *Fig. C*, create more trouble than shells having a plain cylindrical shape. In fact, shells with flanges require much larger blanks than flangeless shells of the same diameter and depth; therefore, greater pressures are needed for the drawing operation in the case of flanged shells. Besides, flanged shells must be ejected upwards after completion of the drawing process instead of being simply pushed through the die as done with flangeless shells. Consequently, the operation becomes slower and therefore more expensive.

Round Noncylindrical Shells: Shapes which give more trouble than cylindrical components include those that are tapered or conically shaped, *Fig. D;* half-spherical, *Fig. E;* and concave shells, *Fig. F.* Reason is that at the beginning of the drawing action there is much larger amount of metal out of control of the die members, which increases the tendency to form wrinkles. To compensate for this difficulty, these shells are made with special tools and in the majority of the cases in several passes. Each of these passes requires a separate set of tools and an extra operation.

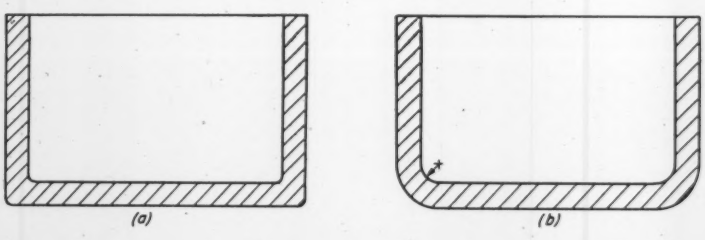
Incidentally, difficulties of production and, therefore, costs increase with the shallowness of components with round noncylindrical shapes.

Rectangular Boxes: In designing square or rectangular drawn sheet-metal parts, the chief factors which must be taken into consideration are practically the same as in round shell drawing, with one difference. Instead of the overall dimensions of the box (width and length), the corner radii are the deciding design factors, *Fig. G.* Therefore, the severity of the draw and other conditions are governed by the height to corner radius ratio, instead of the height to shell-diameter ratio as is the case with cylindrical shells.

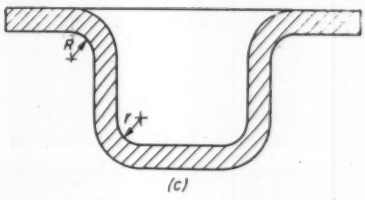
Irregular Workpieces: For the sake of completeness, irregularly shaped parts must be mentioned, *Fig. H.* These are obviously the most expensive shapes because of increased tooling and labor costs along with more waste. Time and labor involved in finding the definitive shape and dimensions of the required flat blank increase production costs of these components considerably.

Practical Design Hints: Here follow a few practical suggestions for the design of inexpensive drawn components:

1

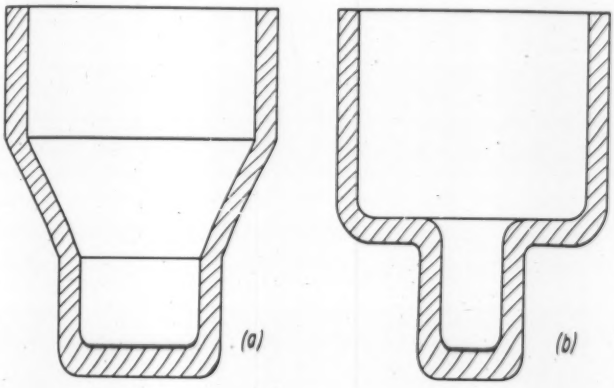


Avoid sharp bottom edges in cylindrical flangeless shells, *a.* Corners should be as round as practical, *b.* However, if it is really necessary to have sharp corners, then the shells are drawn with rounded corners first. After that, the components are placed into a squaring die to change the rounded



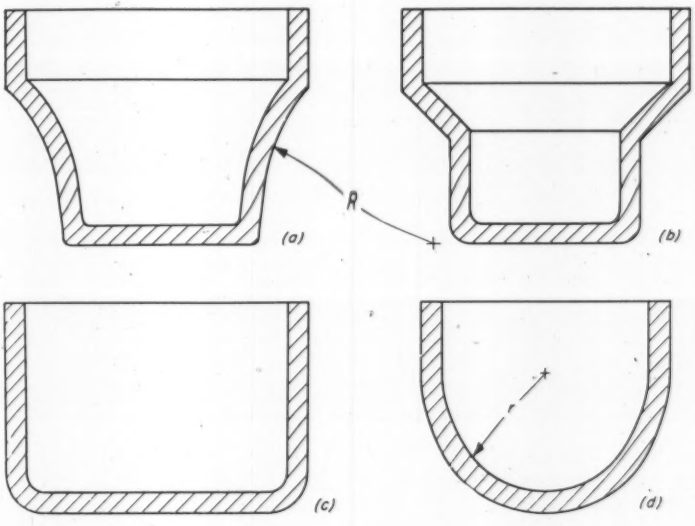
bottom into a flat one. During the squaring operation the shell becomes a little shorter. In flanged shells, *c*, the rounding radius *R* of the flange cannot be chosen arbitrarily, since it is determined by the rounding radius of the drawing die. Radius of the drawing die is governed chiefly by the stock thickness and is usually 6 to 10 times that thickness value. Let the toolmaker determine this radius. As to the inner bottom radius *r*, the same rules apply as for flangeless shells.

2



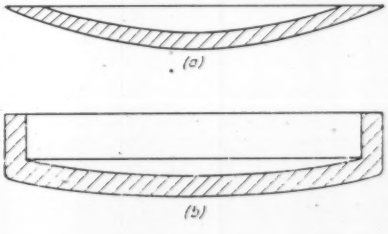
Do not make abrupt changes in section diameters. Shells with reduced parts (hubs) must be designed so that differences in section diameters should be rather small, and transfers from one section to the next should be made by a smooth taper, *a*, (if possible no more than 45 degrees) rather than abruptly, *b*. The shape in sketch *b* can be drawn, but it is very unfavorable and economically unadvisable.

3



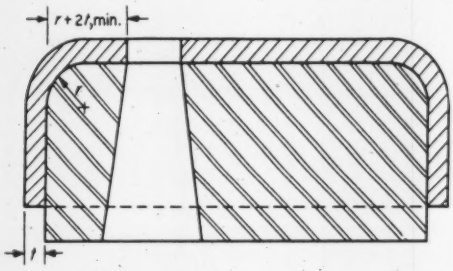
Use cylindrical-sided shells wherever possible because they are less expensive to produce than conical or curvilinear shapes. Whenever possible, change the design of a component from tapered or rounded sides, *a*, into a two-diameter reduced shape, *b*. Similarly, a flat-bottomed shape *c*, would be preferred to a half-spherical design, *d*.

4



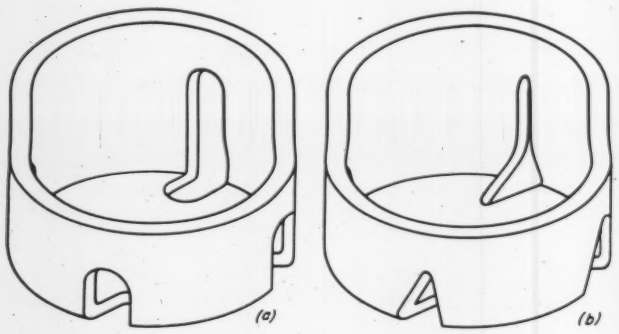
Avoid feather edges on shallow pieces, *a*, from the standpoint of operator and user safety. Besides, such shapes are difficult to produce. Provide a small vertical wall, *b*, on shallow components if at all possible.

5



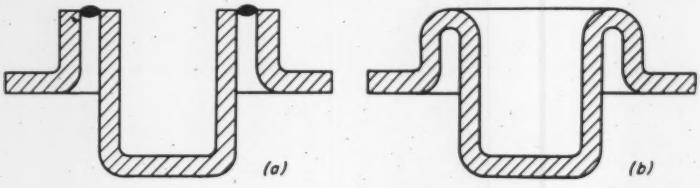
Keep holes away from the shell wall if holes must be pierced in drawn shells. Distance from the edge of the hole to the inner shell wall should be at least twice the stock thickness plus the radius at the bottom of the shell. This prevents tearing of the metal and reduces die wear.

6



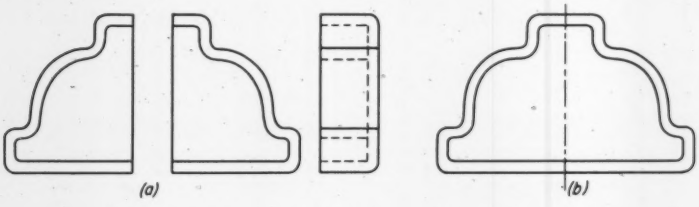
Punch holes before drawing if possible. When hole shape is not critical, such as holes in electrical boxes for introduction of electric wiring, avoid punching after the part is drawn, *a*, because this necessitates special complicated second-operation punching dies which are inherently expensive. Instead call for simple round holes which can be pierced in the flat, round blank before the drawing operation, *b*.

7



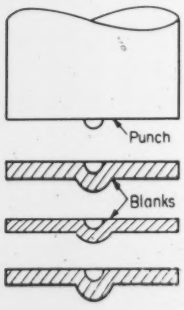
Use a composite construction, *a*, where severe drawing conditions would be encountered by the shape and dimensions of components, such as *b*. The sectional construction involves joining together two or more separately drawn parts by some suitable means such as welding, brazing, etc. For short-run jobs the sectional construction is nearly always simpler and much cheaper.

8



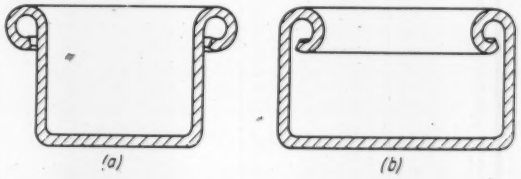
Make irregular right and left-hand parts, *a*, by designing them into a common double part, *b*, for drawing if possible. After completion of the drawing process the two components can be separated with a simple slitting die. This technique can be used where such parts would be rather difficult and expensive to produce separately because of their unfavorable shapes.

9



Prevent sticking together of lubricated blanks by stamping in a small projection whenever the function of the component will allow it. This projection may be made by means of a tip on the blanking punch.

10



Stiffen open ends of shells by curling edges. This will also prevent accidents. Remember that outside curls, *a*, are much simpler, easier and cheaper to make than inside curls, *b*.

A practical approach to selection and application of materials for

OPTIMUM BEAM DESIGN

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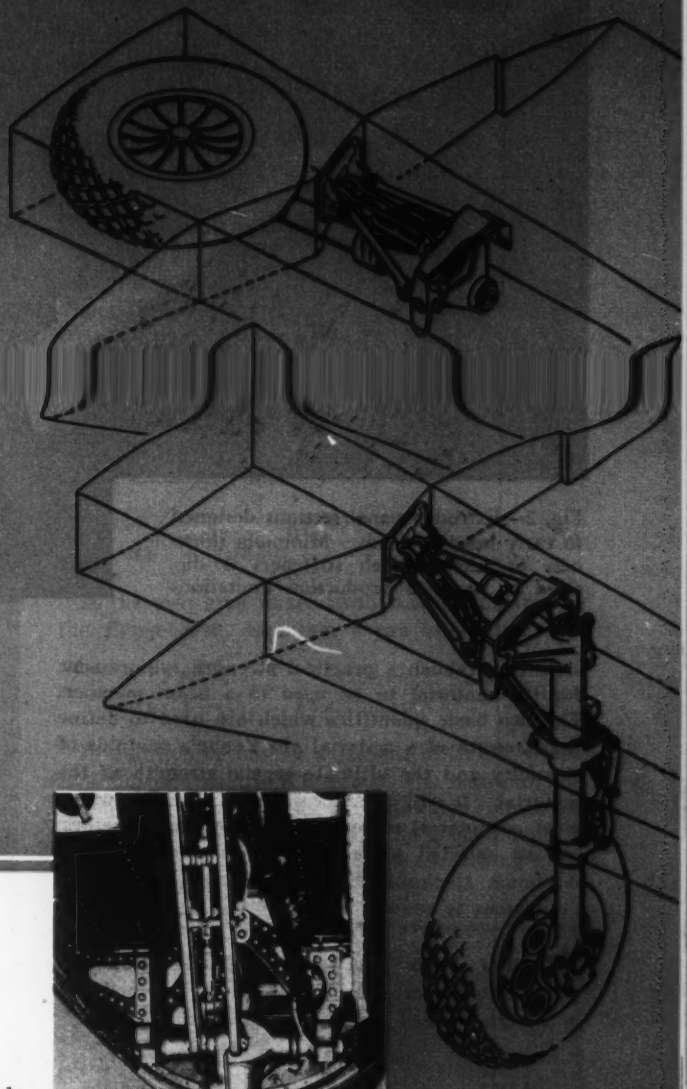


DESIGN of beam members in mechanical assemblies is frequently dictated by considerations other than strength. In cantilever beam structures, for example, tip deflection is often critical and must not exceed a given value. As a typical case, the permissible deflection at the axle of the shock strut of an airplane landing gear is usually limited by functional or stiffness requirements, or by operating clearances with the adjacent structure, *Fig.* 1. Stiffness, rather than strength, is thus the important design criterion. This condition is also true of aircraft components, such as thin wings, control surfaces, etc., where dynamic loads or flutter characteristics could be critical.

Service life and fatigue considerations are other aspects of design that may lead to heavier structures than required by static strength alone. Production limitations also place restrictions on the size or minimum thickness of extruded, forged, or cast beam sections, *Fig.* 2.

When these various limitations exist, it is pos-

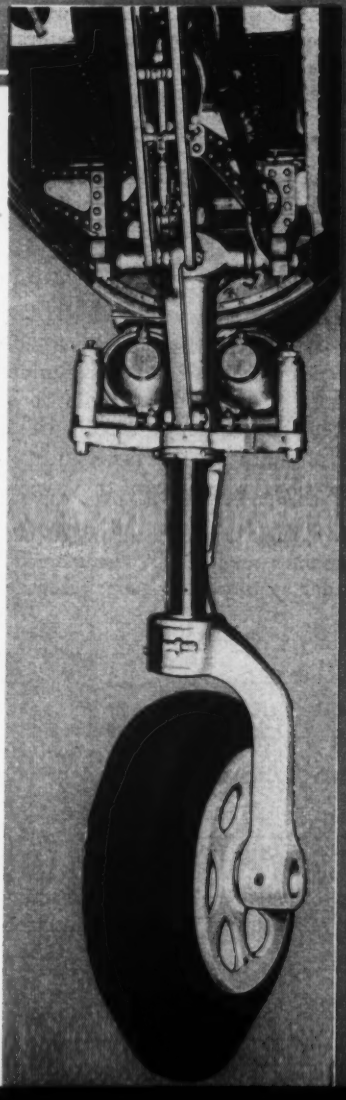


Fig. 1—Typical aircraft landing gear assemblies. Design of beam members is usually based on allowable deflection instead of allowable stress

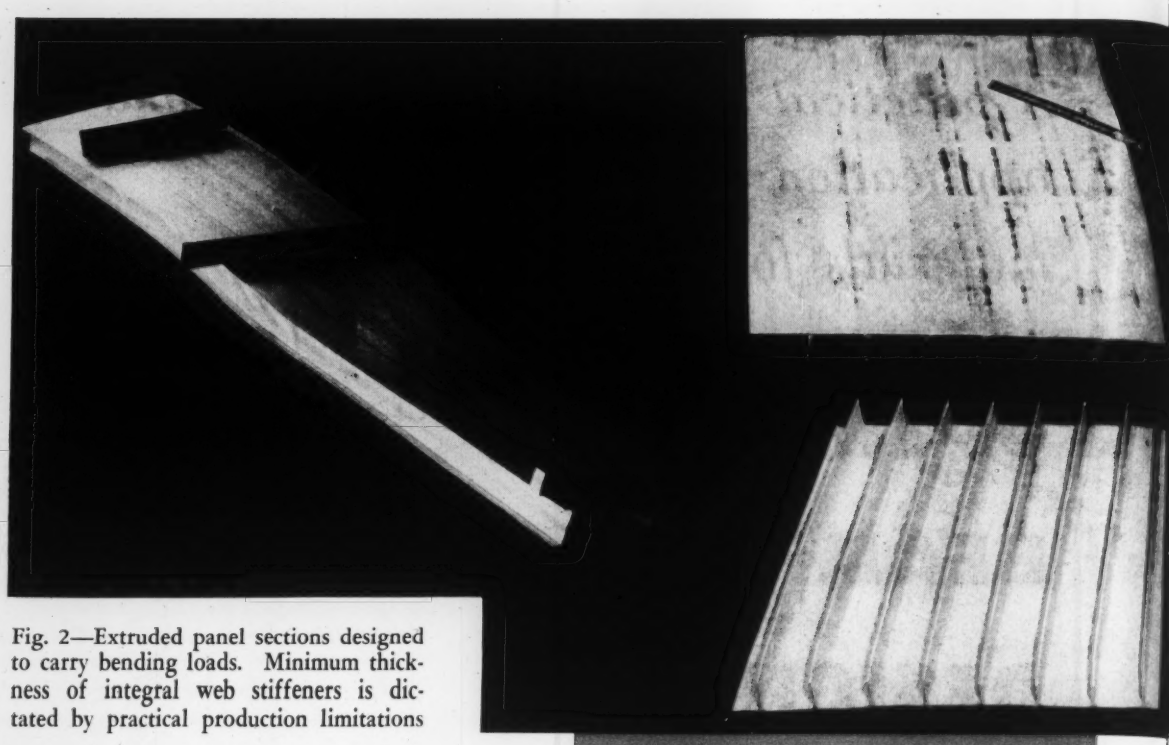


Fig. 2—Extruded panel sections designed to carry bending loads. Minimum thickness of integral web stiffeners is dictated by practical production limitations

sible to establish a practical strength requirement for the material to be used in a beam member. The two basic quantities which are used to define the strength of a material are Young's modulus of elasticity and the ultimate tensile strength of the material. It will be shown in this article how the most economical material, based on these factors, can be selected when an allowable deflection or minimum thickness based on certain production limitations is known.

Tubular Beam Analysis: Cantilever beams of round tubular cross-section, *Fig. 3a*, are common in design. Based on small deflection theory,

$$\delta = \frac{Pl^3}{3EI} \quad \ldots\ldots (1)$$

where symbols are defined in the *Nomenclature*.

This equation is derived under the assumption that higher order effects due to large deflections can be neglected. This assumption is usually valid since the ultimate strength of the material will be exceeded for sections other than thin wide shapes (as in leaf springs) before the large deflection formula becomes applicable. The moment of inertia of a tubular section can be expressed as

$$I = \frac{\pi}{64}\left[D^4 - (D-2t)^4\right] = \frac{\pi D^4}{8K^4}(K^3 - 3K^2 + 4K - 2) \quad \ldots\ldots (2)$$

and, thus, the section modulus becomes:

$$Z = \frac{2I}{D} = \frac{A^{3/2}}{4\pi^{1/2}} \frac{K^2 - 2K + 2}{K(K-1)^{1/2}} \quad \ldots\ldots (3)$$

The relationship of the machinability constant K to the structural efficiency of the tubular section

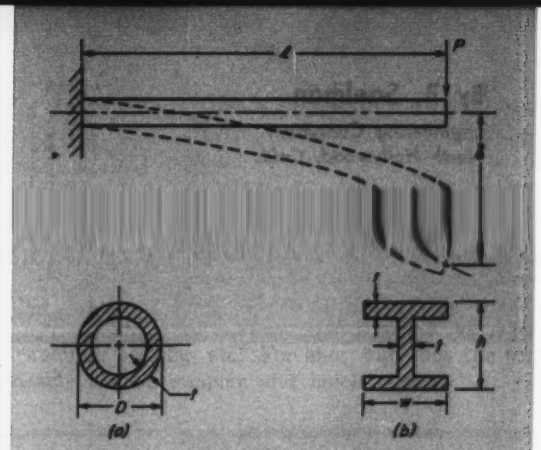
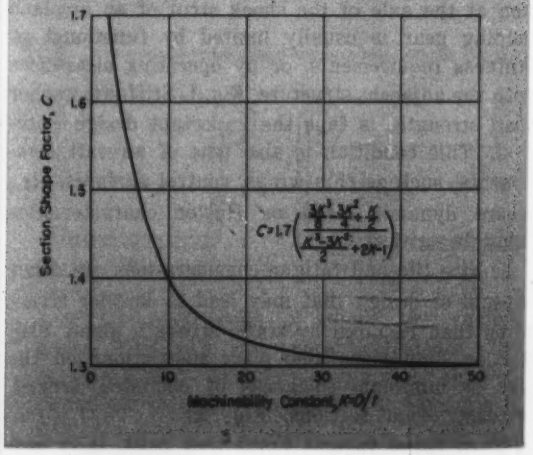


Fig. 3—Above—Analysis of cantilever beam under bending load showing dimensional notation for, *a*, round tubular section and, *b*, I-section

Fig. 4—Below—Section shape factor for round tubular beam sections of varying diameter - thickness ratio



now becomes apparent. From Equation 3, it can be seen that when cross-sectional area A is held constant section modulus Z increases with K. Thus, the section becomes more efficient in bending as K increases. Moreover, I is a maximum, and deflection due to bending a minimum, when K is a maximum.

Combining Equations 1 and 2 gives

$$E = \frac{8\,Pl^3\,K^4}{3\,\delta\pi\,D^4\,(K^3 - 3\,K^2 + 4\,K - 2)} \quad \ldots\ldots (4)$$

If the tubular beam is to be designed for minimum weight, the material distribution will correspond to a maximum value of K. For large values of K, Equation 4 becomes

$$E = \frac{0.85\,Pl^3\,K}{\delta\,D^4} = \frac{0.85\,nKl^3}{D^4} \quad \ldots\ldots (5)$$

where the spring constant, n, is defined by

$$n = \frac{P}{\delta} = \frac{3\,E\,I}{l^3} \quad \ldots\ldots (6)$$

A useful relationship when K is large is:

$$I = \frac{A\,D^2}{8} = \frac{\pi\,D^3 t}{8} \quad \ldots\ldots (7)$$

From Equation 1, using the foregoing relationship and $t = D/K$, Equation 5 can be derived directly by substitution. Equation 5 indicates that for a fixed diameter D, the required modulus E increases as K increases and decreases as deflection δ increases. When the beam length, diameter, spring constant and machinability constant are given, the minimum value of E can be determined.

For illustration, a typical problem will be considered. Given design data are: $P = 2000$ lb, $l = 15$ in., $K = 60$, $D = 3$ in., and $\delta = 0.50$-in. From Equation 5, $E = 8.54 \times 10^6$ psi, while from Equations 1 and 2, which give a more exact relationship, $E = 8.92 \times 10^6$ psi. For this example an aluminum alloy with a modulus of elasticity of $E = 10.3 \times 10^6$ would suffice.

I-Beam Analysis: Because of its high inherent efficiency, the I-section is probably the most widely used beam section in design. For the cantilever I-section beam, *Fig. 3b*,

$$I = \frac{w\,t\,(h-t)^2}{2} + \frac{t\,(h-2t)^3}{12} \quad \ldots\ldots (8)$$

The minimum value of E is given by

$$E = \frac{Pl^3}{3I\delta} = \frac{4\,Pl^3}{\delta t[6w(h-t)^2 + (h-2t)^3]} \quad \ldots\ldots (9)$$

If the web area is relatively small compared to the flange area, Equation 9 can be written,

$$E = \frac{2\,Pl^3}{3\delta\,wt(h-t)^2} = \frac{2\,Pl^3}{3\delta\,A_f(h-t)^2} \quad \ldots\ldots (10)$$

In addition to having sufficient stiffness, which is a function of the E value of the material, the beam must not exceed the allowable stress of the material when its deflection is a maximum. A relationship between required beam strength σ_u

Table 1—Section Shape Factors

Section Shape	Factor, C
I-section (flanges only)	1.0
I-section, channel or box	1 to 1.5
Solid rectangle	1.5
Thin-walled tube	1.3
Solid round	1.7
Diamond	2.0

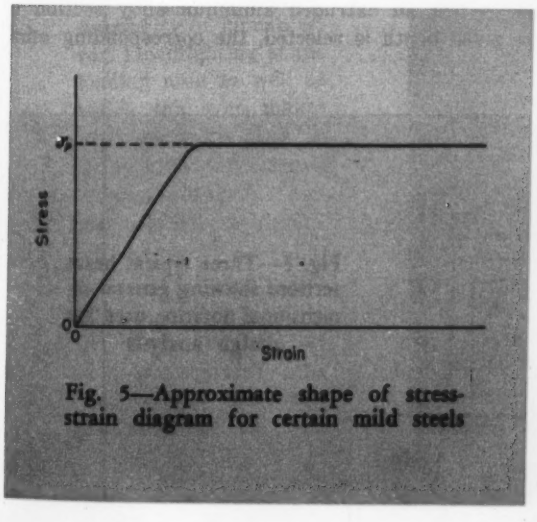


Fig. 5—Approximate shape of stress-strain diagram for certain mild steels

Nomenclature

A = Area, in.^{2}
A_f = Flange area, in.^{2}
C = Section shape factor
D = Outside diameter of tubular cross section, in.
E = Young's modulus of elasticity, psi
h = Depth of beam cross section, in.
I = Moment of inertia of beam cross-sectional area, in.^{4}
$K = D/t$ = Machinability constant
l = Effective beam length, in.
M = Bending moment, lb-in.
M_r = Root bending moment, lb-in.
n = Spring constant
P = Load, lb
Q_m = Maximum static moment, in.^{3}
t = Thickness, in.
t_f = Flange thickness, in.
t_w = Web thickness, in.
w = Width of beam cross section, in.
Z = Section modulus, in.^{3}
δ = Beam deflection, in.
σ_b = Bending stress, psi
σ_p = Elastic limit stress, psi
σ_u = Ultimate tensile stress, psi

and allowable deflection can be established.

The basic flexural formula is

$$\sigma_b = \frac{M_r h}{2I} = \frac{Plh}{2I} \quad \ldots\ldots (11)$$

Combining Equations 1 and 11 gives

$$\sigma_p = \sigma_b = \frac{3h E \delta}{2l^2} \quad \ldots\ldots (12)$$

This equation gives the minimum strength for elastic stress distribution of a section designed for maximum deflection. For the previous calculation example, assuming $h = D/2 = 1.5$ in. and $\delta = 0.5$-in., $\sigma_p = 51{,}500$ psi. Since modulus of elasticity E for all of the aluminum alloys is approximately the same, while the ultimate tensile strengths have a large range of values, the aluminum alloy which has an elastic limit strength slightly greater than 51,500 psi should be selected.

Table 2—Comparison of Maximum Beam Deflections*

Section Shape	Maximum Deflection, δ_{max} Elastic	Plastic
Solid rectangle	$\frac{2\sigma_p l^2}{3Eh}$	$\frac{40\sigma_p l^2}{27Eh}$
Solid round	$\frac{2\sigma_p l^2}{3ED}$	$\frac{1.56\sigma_p l^2}{ED}$

*Based on material with stress-strain characteristics as shown in *Fig.* 5, elastic stress distribution at root section, and all root fibers at elastic limit stress.

Table 3—Minimum Wall Thickness for Aluminum-Alloy Extrusions*

Circumscribing Circle Diameter (in.)	Minimum Wall Thickness (in.) 3003 6063	6061 6062	2014	2024 7075
Under 13	0.093	0.109	0.125	0.156
13 to 16	0.109	0.125	0.156	0.187
16 to 19	0.125	0.140	0.171	0.250
19 to 23	0.140	0.156	0.187	0.375

*Solid shapes only; max weight = 2300 lb, max length = 90 ft.

Stress-Strain Characteristics: Efficient beam design requires that operating beam stresses be in the plastic range. If it is assumed that each fiber of the section is working to maximum stress σ_u, then, by integration, for symmetrical sections

$$M_r = 2\sigma_u Q_m \quad \ldots\ldots (13)$$

Combining Equations 11 and 13 gives an expression that can be related to the quantity $C\sigma_u$:

$$\sigma_b = \frac{\sigma_u Q_m h}{I} = C\sigma_u \quad \ldots\ldots (14)$$

From Equation 14,

$$C = \frac{2Q_m}{Z} \quad \ldots\ldots (15)$$

As indicated in Equation 14, C is the ratio of bending modulus of rupture to ultimate tensile strength. It is a measure of the additional load that can be carried due to plastic effects. Representative values of C for various sections are given in *Table* 1. Section factors for round tubes with varying values of K have been plotted in curve form in *Fig.* 4.

On the assumption that the stress-strain diagram of a material is of the general shape shown in *Fig.* 5, which is approximately true for certain mild steels, it is interesting to compare the maximum deflections for cantilever beams of rectangular and round cross section when the root sections have a purely elastic stress distribution and when all of the fibers of the root sections are at the elastic limit stress, *Table* 2.

Production Considerations: Extrusions, forgings, and castings are subject to minimum size limitations because of practical production considerations. This condition is particularly true for wall or web thicknesses. A tabulation for various aluminum alloys of minimum web thickness, corresponding to the diameter of the circle which circumscribes the extruded section, is given in *Table* 3. When an extruded aluminum-alloy section of a given depth is selected, the corresponding mini-

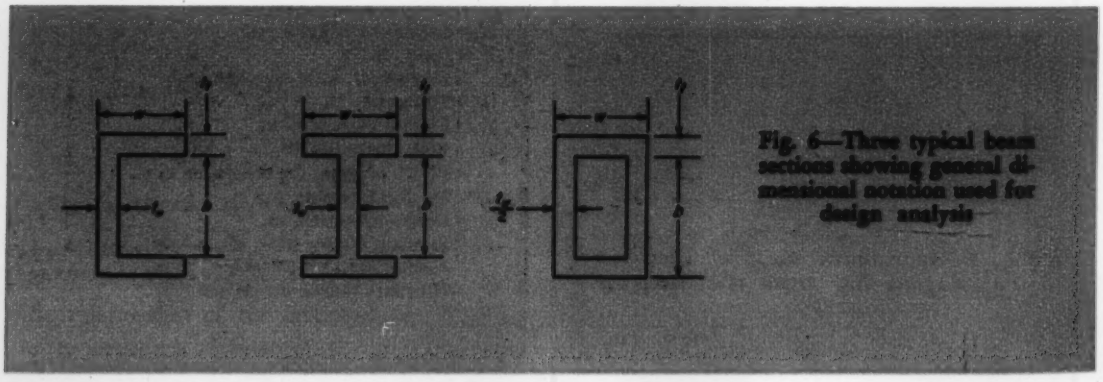


Fig. 6—Three typical beam sections showing general dimensional notation used for design analysis

mum wall thickness can be found from this table and the strength of the section can then be calculated. The table values are applicable to most conventional solid shapes, including I-sections, channels, rectangular tubes, etc.

Maximum Section Strength: The same method of approach employed for the derivation of Equation 15 can also be used to find an expression for the maximum practical strength of a beam as a function of minimum dimensions and moment. This relationship is:

$$\sigma_u = \frac{M_r}{\frac{t_w b^2}{4} + w\left[\left(\frac{b}{2} + t_f\right)^2 - \frac{b^2}{4}\right]} \quad \ldots\ldots (16)$$

Equation 16 can be used to determine the maximum practical strength of the three sections shown in *Fig.* 6. Conversely, if the strength value of the section is given and the allowable bending moment is to be determined, the following equation, which uses section factor C, is sometimes more convenient:

$$M_r = \frac{2C\sigma_u I}{b + 2t_f} \quad \ldots\ldots (17)$$

From the method of approach previously discussed,

$$C = \frac{\left(\frac{b}{2} + t_f\right)\left\{\frac{t_w b^2}{4} + w\left[\left(\frac{b}{2} + t_f\right)^2 - \frac{b^2}{4}\right]\right\}}{2w\left(\frac{t_f b^2}{4} + \frac{t_f^2 b}{2} + \frac{t_f^3}{3}\right) + \frac{t_w b^3}{12}} \quad (18)$$

If $t_f = 0$, the section degenerates into a rectangular section and Equation 18 yields $C = 1.5$. If $t_w = 0$, all of the material is concentrated in the flanges of the section and, assuming b is large compared to t_f, C is approximately unity.

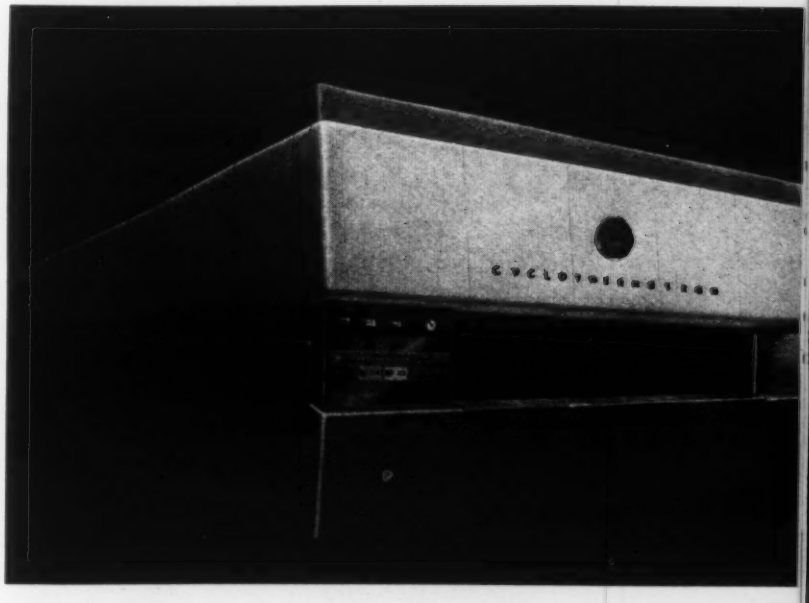
Contemporary Design

Cyclothermotron Is Versatile Oven

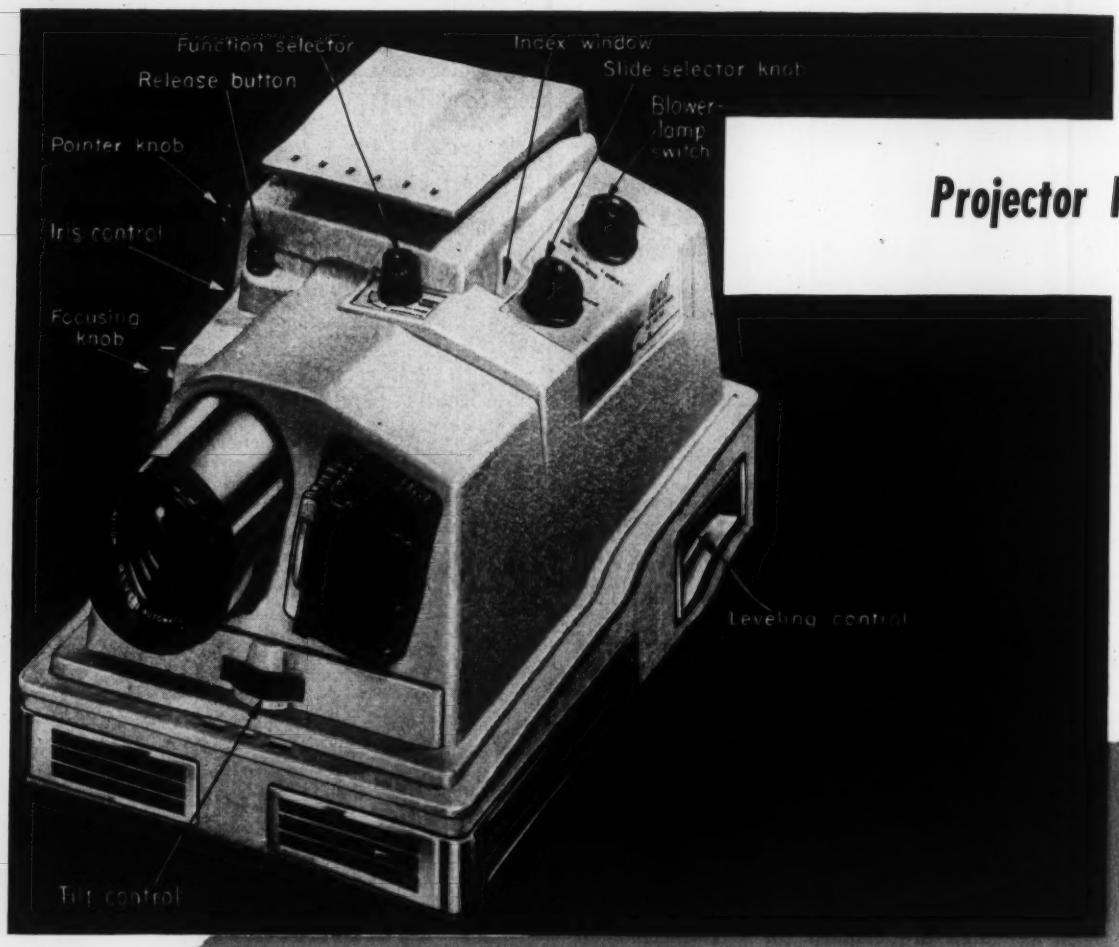
MANY radical innovations in bake oven design are claimed for Cyclothermotron, recently introduced at the 1955 Baking Industry Exposition in Atlantic City. A complete departure from conventional design, stylingwise, the oven is available in two and three-tone color combinations.

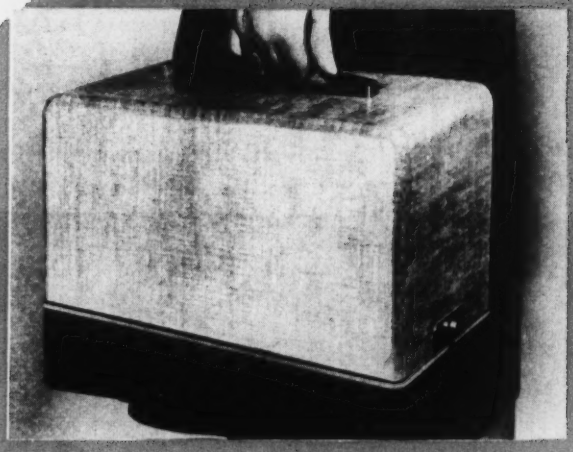
Color is also put to work to visually relate control systems for safer operations. A color-coded, integrated instrument panel gives quick visual orientation of control instrument relationships to reduce the possibility of human error. Floodlighting at the loading area as well as inside the oven makes good visibility possible through the large vision windows at front and sides.

Built by the Haller Oven Co. in capacities of 2000 to 6000 lb of bread per hour, the machine also incorporates self-loading and automatic unloading systems.



Projector Is

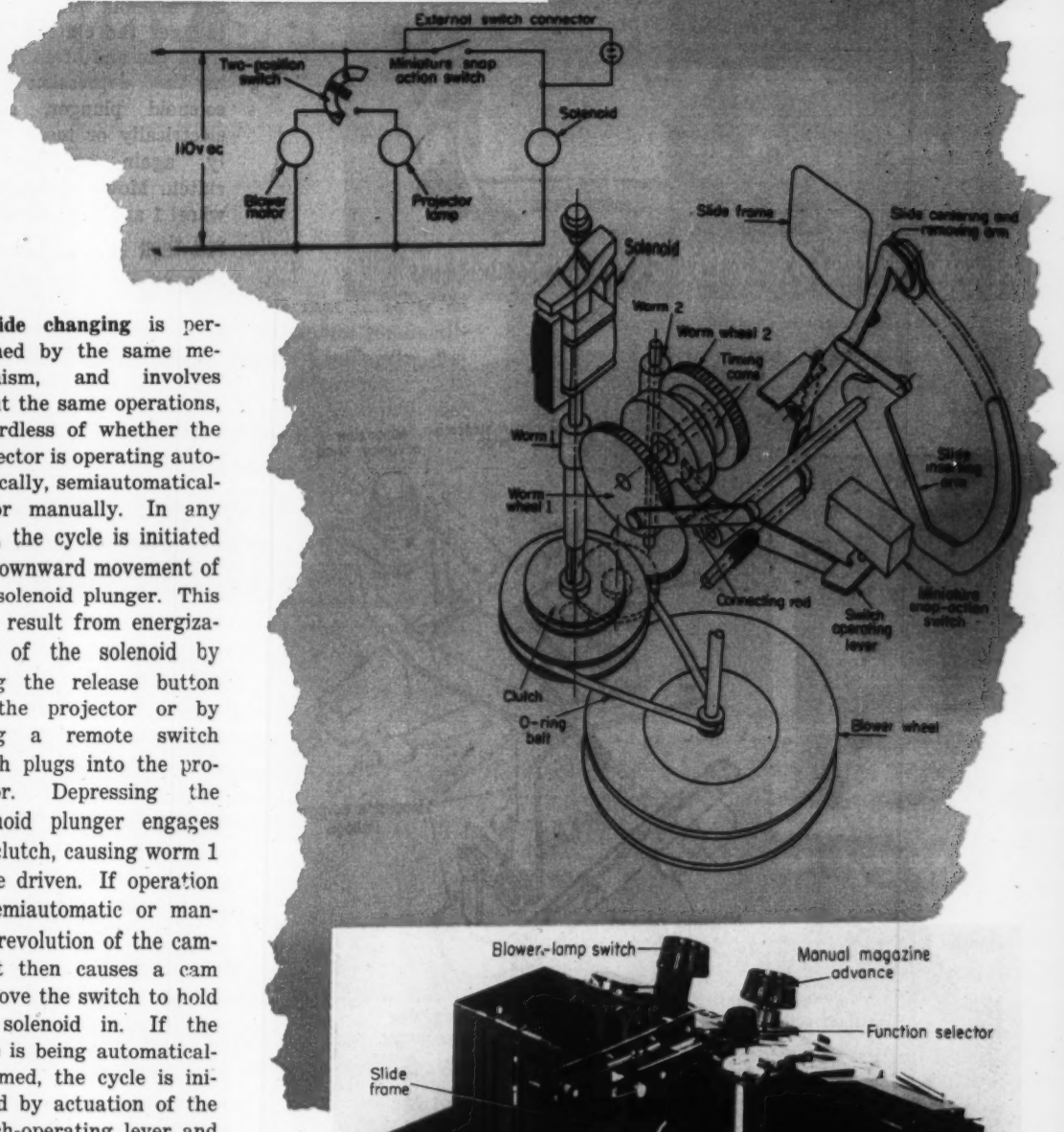




ALTHOUGH the user must place color transparencies in a magazine and then insert the magazine into a recently developed Revere projector, the remainder of the operation is almost fully automatic. When loaded and properly set, the projector will show a sequence of 36 slides, 2 by 2 inches, with no attention from the operator. A function selector switch permits the selection of intervals of approximately 5, 10 or 15 seconds between successive slides. In addition to fully automatic operation, semiautomatic and manual operation are provided in the same projector.

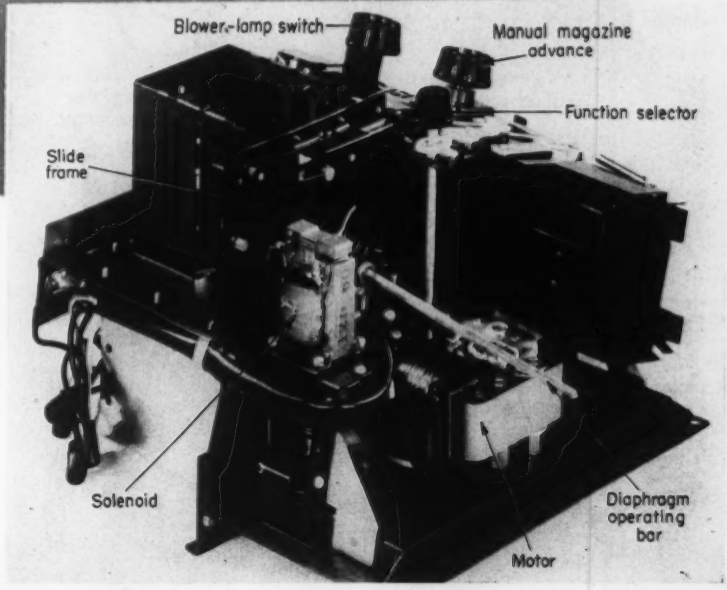
Other features of this machine are 500-watt light source, an iris diaphragm which closes automatically during the time slides are being changed, an integral pointer whose image is projected on the screen, leveling and tilt controls, and a cover which converts the projector into a carrying case. A small screen in the cover can be used for table-top projection. Called the Revere 888, the projector is a product of the Revere Camera Co.

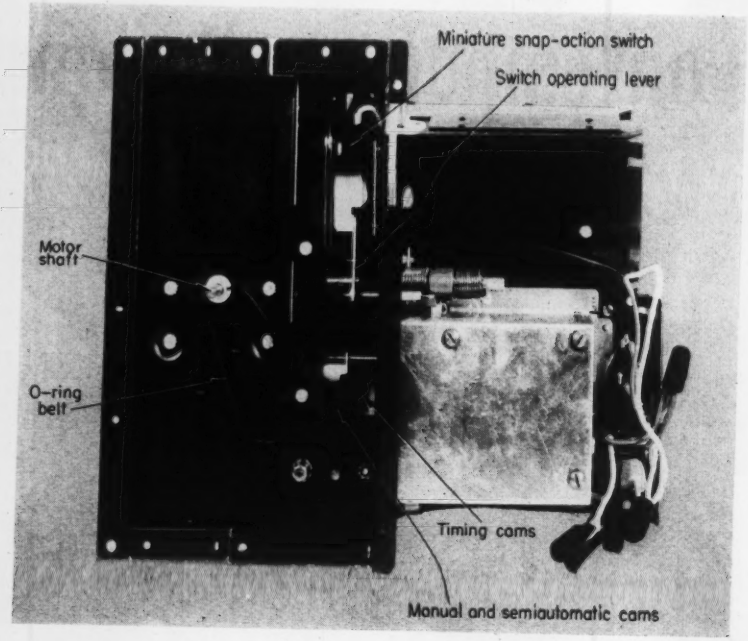
Completely Automatic



Slide changing is performed by the same mechanism, and involves about the same operations, regardless of whether the projector is operating automatically, semiautomatically or manually. In any case, the cycle is initiated by downward movement of the solenoid plunger. This may result from energization of the solenoid by using the release button on the projector or by using a remote switch which plugs into the projector. Depressing the solenoid plunger engages the clutch, causing worm 1 to be driven. If operation is semiautomatic or manual, revolution of the camshaft then causes a cam to move the switch to hold the solenoid in. If the cycle is being automatically timed, the cycle is initiated by actuation of the switch-operating lever and switch by one of the three timing cams.

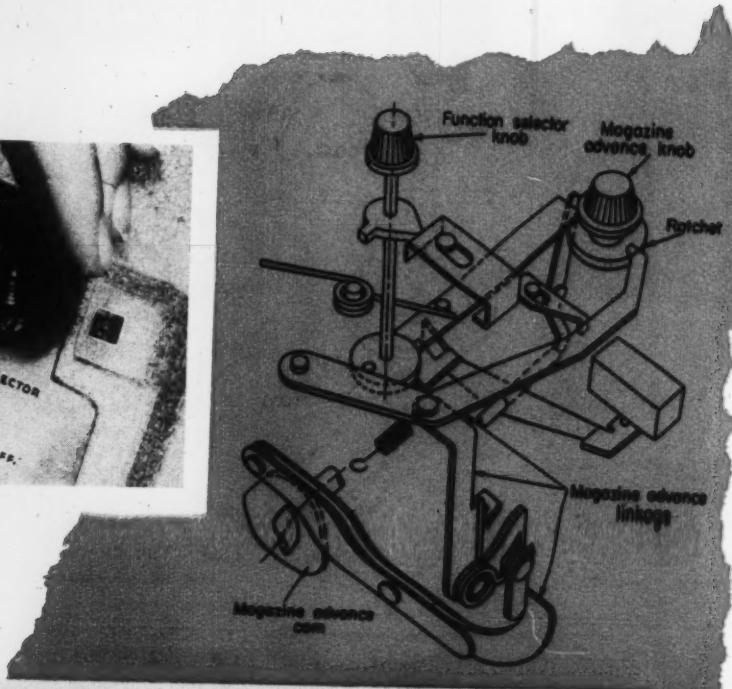
Revolution of the crank then causes the slide inserting arm to push a slide into the slide frame. Arrangement of the linkage causes the slide inserting arm to move faster than the slide centering and removing arm so the slide is firmly held between the two during projection. Cen-



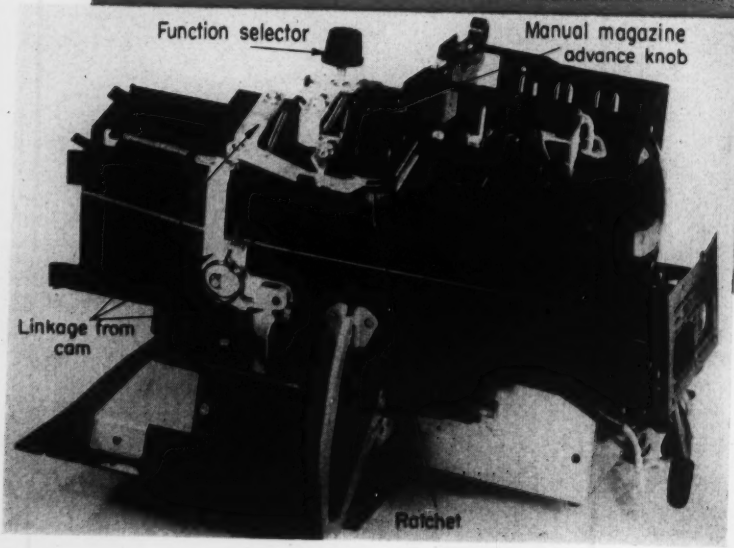


tering is automatically accomplished by the small grooved nylon wheel on the centering and removing arm. When the slide is in viewing position, the switch operating lever is released by the cam, the miniature snap-action switch contacts open, and the solenoid plunger disengages the clutch.

At the end of the viewing time, depression of the solenoid plunger, either electrically or mechanically, again engages the clutch. Movement of worm wheel 1 and the connecting rod then returns the slide to the magazine.



Automatic slide magazine advance is accomplished by a cam on the shaft of worm wheel 1, a system of levers and a ratchet mechanism. Selection by number can be made when slides are being changed manually by depressing the release button each time a slide is to be viewed or returned to the magazine. Numbers corresponding to the slides are visible through a window. A cam at the upper end of the function selector shaft pushes the dog away from the ratchet when the function selector knob is in the *manual* position. Another cam on the same shaft actuates the diaphragm through sector gears. This blocks light from the screen during the changing cycle. An adjustable stop on this mechanism allows limiting of the maximum aperture of the diaphragm when conditions do not require full light output of the projector.



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Why Specify Ductility?

Still entrenched in the folklore of design engineering is the notion that specifying high ductility for metals and alloys insures reliable service performance. A close look at the evidence discloses no basis for such an idea. But there are still valid reasons for specifying ductility

IT HAS OFTEN been stated[1] that there is no relation between tension test values for ductility and the incidence of failures in service. Designers admit that neither elongation nor reduction of area constitutes design data. Despite this, there is a reluctance to give up the old idea that the more ductile a material is in the tension test, the better its chance of survival under service conditions.

If two dissimilar alloys have the same strength values but differ in elongation in the tension test, would the less ductile metal be less serviceable than the other? Gillette[2] and those who agree with him do not think so.

A steel, by heat treatment, can be made stronger and at the same time less ductile. Does this mean that stronger steels are less serviceable because of this decreased ductility? Quite obviously, the answer to this question is also "no."

In general, five conditions may promote fracture in service:

1. Fatigue
2. Stress raisers
3. Impact loading
4. Loading at low temperatures
5. Loading at elevated temperatures.

Actual failure may be caused by any one of these conditions or by some combination of them.

Fatigue Failures: It has been demonstrated that initial failure in fatigue is always associated with slip bands, which are the metallographic evidence of plastic deformation. The plastic flow in one or two crystals detected by a microscope, and plastic flow in the entire mass of a specimen as measured by an extensometer, may well be two entirely different things. It has been well established[3] that there is no relation between endurance limit of a given material and its elongation in the tension test.

Notch Effect: Examination of parts which have failed in service often indicates that the origin of the crack is at a notch or stress raiser. These failures almost invariably are of the brittle type, which would seem to rule out any connection with ductility in the tension test.

However, there is always a plastic zone at the base of the notch. Again, this is determined metallographically.

Notch tensile tests on structural alloy steels have shown that the initial high stress concentration due to the notch decreases with plastic flow and becomes negligible in specimens which possess enough ductility to flow 2 per cent without failure. For certain aluminum or zinc-base aircraft alloys an elongation of 1 or 2 per cent is sufficient to relieve stress concentration due to rivet holes.

It seems, therefore, that some ductility is necessary to alleviate the action of the stress raiser, but quite apparently the amount of ductility required is very low and well within the capabilities even of alloys normally regarded as rather brittle.

As a first approximation, any alloy which has a specified minimum ductility should be able to handle the notches encountered in service.

Impact: Impact fractures invariably are of the coarse, brittle type. Evidence of plastic deformation has been found in the surfaces of brittle fractures of iron. Some brittle fractures contain about

1. References are tabulated at end of article.

2 per cent plastic deformation, extending a few millimeters below the surface of fracture. Recent Russian work estimates the amount of plastic deformation in brittle fractures to be as high as 5 per cent. Here, again, there is temptation to relate a measurement of plastic flow in a few grains with a measurement of plastic flow in a body of macroscopic dimensions.

There is danger in trying to relate the plasticity observed in impact fractures with elongation in the tension test. Actually, the mechanism of plastic flow and of the propagation of deformation in impact is fundamentally different from that in the static test.

Low Temperatures: It is well known that all metals suffer some loss in ductility at low temperature. Metals and alloys which crystallize in the face-centered cubic or hexagonal close-packed systems possess what is referred to as a transition temperature, *Fig.* 1. Above the transition temperature range, the fractures are essentially ductile; below this narrow range of temperatures, they are entirely brittle. This fact is of importance since the nonaustenitic steels and zinc alloys belong to the class described here.

The higher this transition temperature, the more readily a material is embrittled and, it might be suspected, the more likely it would be to fail in service, *Fig.* 2. It cannot be assumed that an alloy which possesses high elongation in the tension test at room temperature will be more difficult to embrittle than one which is less ductile.

Of importance in this connection is the temperature of transition, which depends on the method of loading. For a given material the transition temperature in cross-bending is not the same as it is in tension testing, for example. Thus, there is no relation between transition temperatures in laboratory tests and transition temperatures of structures.

There seems little likelihood, then, of relating elongation or reduction of area in the tension test to probability of service under low-temperature conditions.

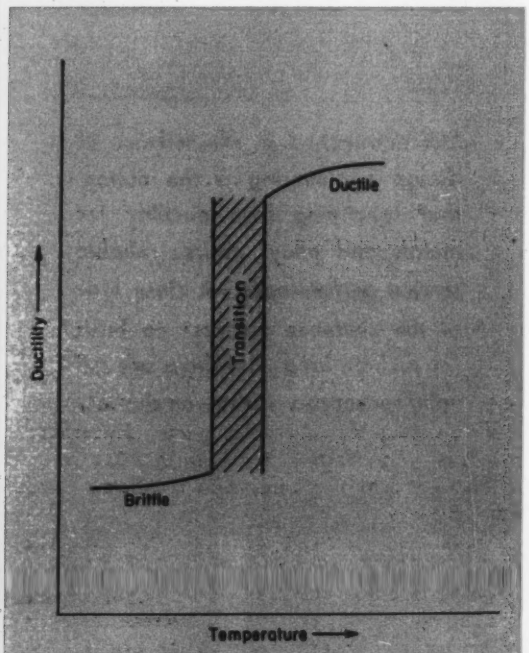

Fig. 1—Certain metals and alloys are relatively brittle below the "transition" temperature, relatively ductile above it

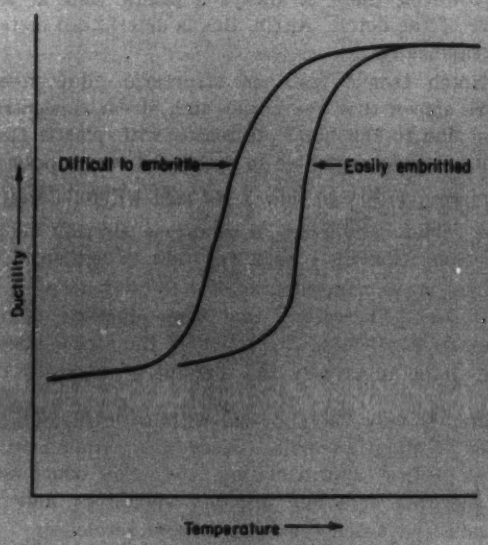

Fig. 2—A material with a high transition temperature is more easily embrittled than one with a lower

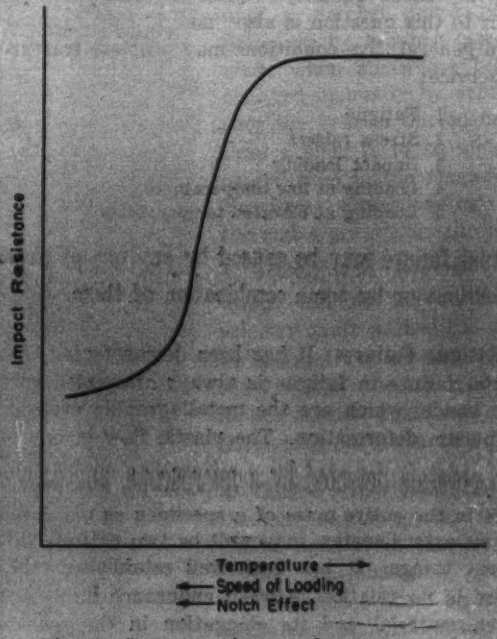

Fig. 3—Impact resistance decreases as temperature decreases, and as speed of loading and notch effect increase

High Temperature: The chance of failure at elevated temperature is another case which seems unlikely to relate to room-temperature ductility values. The amount of plastic flow which can be obtained under elevated temperature test conditions depends considerably on the type of test or service conditions encountered. It has been noted that the usefulness of ductility in stress-rupture tests has always been controversial, and in such tests the ductility is rather erratic, even in the case of duplicate tests.[4] However, for certain alloys at least, there is no correlation between failure at elevated temperatures and room-temperature ductility as measured in the tension test.

Combinations of Conditions: Service conditions are almost always much more complex than test conditions. What is the relation between tension test ductility and the more generalized service conditions?

High temperature fatigue has been shown to depend on many factors which would not affect the static tension elongation. In a combination of fatigue and stress raiser it can be shown[3] that the fatigue limit depends not only on the material and the stress conditions, but also on the notch and probably on the reaction of the material to a given notch. Again, this eliminates any probable relation between the results of a given test for service application and elongation in tension.

Three of the conditions discussed—notch effect, impact loading, and low temperature—constitute the three well-known embrittling effects, *Fig.* 3. These effects are frequently combined in various ways in service conditions. It has been stated that, in the event more than one factor is present, the effect of any one factor is not necessarily independent of the effects of the other factors. In fact, a scheme has been worked out which shows qualitatively this interrelation of embrittling factors. In essence, it may be said that a certain amount of embrittlement must occur to cause brittle fracture. When the sum of embrittling effects of each factor reaches this amount, brittle fracture occurs, *Fig.* 4. Quite obviously, if any one factor contributes a large amount of embrittling, then the other two factors need contribute very little.

Since no relation could be found between tension test ductility and these factors separately, it seems hopeless to find a relation between ductility and a combination of them. However, one test which incorporates to a greater or less extent all three embrittling factors is the notched-bar impact test, which is run at a series of temperatures. It has been shown that the key-hole Charpy value for low-alloy cast steels at room temperature can be computed satisfactorily from the tensile strength and reduction of area as measured in the tension test. There may be a possibility of computing such a relation for V-notched bars.

However, the test which best gages the tendency to service failure is the V-notch Charpy test at low temperatures and it seems unlikely that there would be any relation between low-temperature Charpy values and those at room temperature. Therefore, any relation between ductility in the tension test and low-temperature Charpy seems unlikely.

It has been demonstrated that the transition temperature in notched-bar impact testing depends on heat treatment, the existing stress state, the analysis of the material, and on the practice used in preparing the alloy. Thus, two steels of identical mechanical properties may have entirely different transition temperatures and, therefore, different

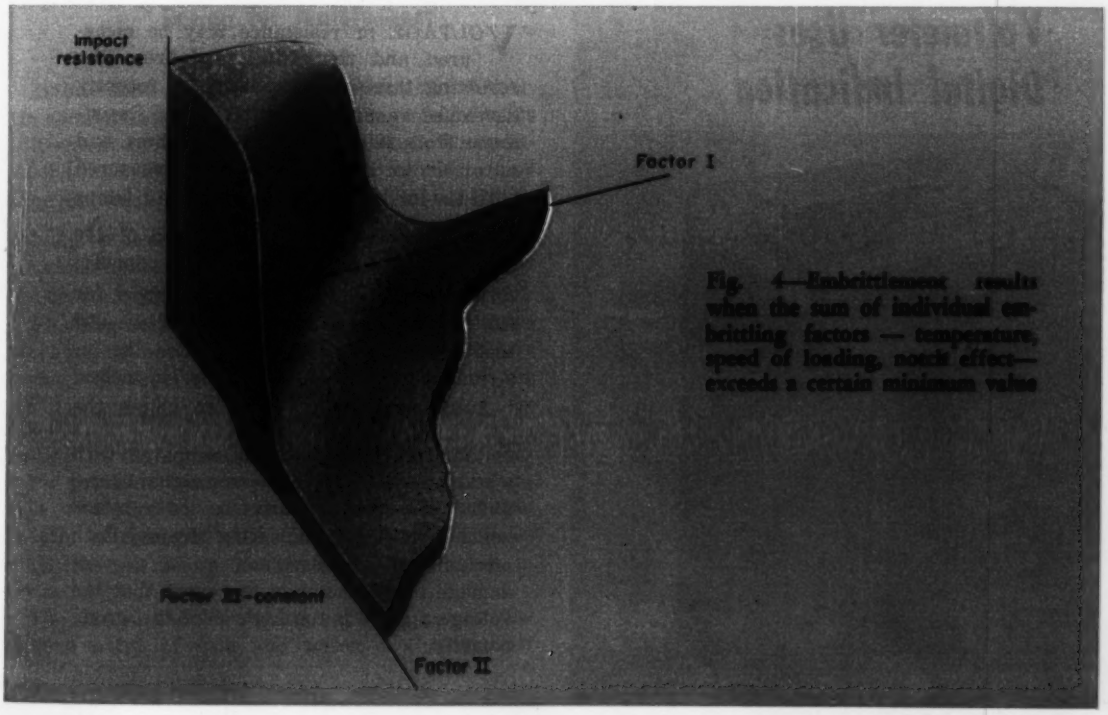

Fig. 4—Embrittlement results when the sum of individual embrittling factors — temperature, speed of loading, notch effect— exceeds a certain minimum value

tendencies toward brittle fracture.

Due to the existence of the transition temperature, two samples may have the same room-temperature Charpy values, yet one could be more easily embrittled and less serviceable than the other. A high room-temperature Charpy value is not a guarantee of serviceability.

It has been admitted that the room-temperature notch-bar impact test is not generally useful in predicting service failures. However, very little room-temperature impact resistance is required for some conditions. A correlation has been found between the tendency to service failure in gear teeth and the room-temperature Izod value. An Izod value of only 5 ft-lb was found necessary for materials that would be successful in a gear.

Why Write Ductility Specifications? The answer to this question is relatively simple. Some authorities regard the ductility specifications as quality indexes, that is, as aids in judging whether or not an alloy has been properly prepared.

Because of the peculiar conditions existing in the tension test, some materials like steel are quite ductile. If it has been found that a well-manufactured steel of, say, 100,000 psi tensile strength has an elongation of 20 per cent, we expect that all steel made for us at this strength level will have 20 per cent elongation. If the steel falls short of this criterion, we reject it, not because it will fail in service due to lack of ductility, but because some unknown has crept into the processing, which may cause failure.

So long as a material will pass a specification calling for 3 to 5 per cent elongation, it will probably have enough ductility to take care of the average notch. As already noted, the relief of stress raisers is the only place where a relation can be shown between required ductility and service.

As was pointed out by Gillette[2], it is a rare service application which will permit very much plastic deformation; an airplane wing becomes aerodynamically useless if it elongates 1.5 per cent. Therefore, any ideas of using 10 to 20 per cent elongation in service are probably not realistic.

Conclusion: Wherever stress raisers are encountered in application, a little ability to deform plastically is required of the metal to relieve the notch effect. Any further ability to deform permanently is probably wasted because the application will not permit these great deformations.

Generally speaking, there is no relation between the ductility of a metal or alloy in the static tension test and the probability of a failure under service conditions. Therefore, the ductility in the tension test can be used only as a guide in deciding whether or not the metal or alloy has been produced under normal satisfactory conditions.

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3. R. Cazand and L. Persoz—*The Fatigue of Metals* (translated from the French by A. J. Fenner), London, Chapman, Hall Ltd., 1953.
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Contemporary Design

Voltmeter Uses Digital Indication

VOLTAGE or resistance may be measured and the value read from the revolving three-digit counter of a recently developed vacuum-tube voltmeter. Resistances from 1000 ohms to 10 megohms, and ac or dc to 1000 volts, can be measured with the instrument. Small indicator lamps automatically indicate the position of the decimal point as well as voltage polarity. A maximum of 5 seconds is required for the indicator reading to change from 000 to 999. Made by Hycon Mfg. Co., the instrument measures 8½ by 11 by 7½ inches.

A servo system is used in which the voltage being measured is compared with a standard voltage. The error signal is amplified and used to drive a servo motor which drives the indicating drums. Both mechanical and electrical stops prevent damage to the meter in the event that the voltage applied is too high or of the wrong polarity.

Gear Lubrication

How to design the gear unit to maintain lubricant properties, and experimental suggestions for meeting unusual operating conditions.

Part 3–Design for Maintenance, and Experimental Suggestions

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TWO important aspects of gear lubrication are considered in this article—designing for gear maintenance, and experimental suggestions for meeting unusual conditions. Design for maintenance of a gear unit is primarily design for maintenance of the lubricant. Experimental suggestions covered here are directed at arriving at the proper lubricant.

Previous, articles (November and December 1955) have considered fundamentals and problems of gear lubrication, and selection of the lubricant. This article is the third and final article in the series.

Design for Maintenance

Maintenance itself is not the job of the designer. He should, however, be aware of the problem to its full extent in the process of designing. The principal points of gear-unit maintenance consist of oil changes, and flushing and cleaning the unit (including its bearings). This should be feasible with a minimum of disassembling and consequent tampering with the fit and alignment of the unit.

Flushing and cleaning may be necessary because of changing operating conditions, but particularly because of deterioration or contamination of the oil. Deterioration is mainly due to oxidation, resulting in the formation of acid and sludge. **Metallic particles from wear promote this deterioration catalytically even when they settle at the bottom of the gear case.** Morover, such particles may damage the gears by sticking to them in operation, *Fig.* 1.

The design should provide as much as possible against entry of dust and water. Unfortunately,

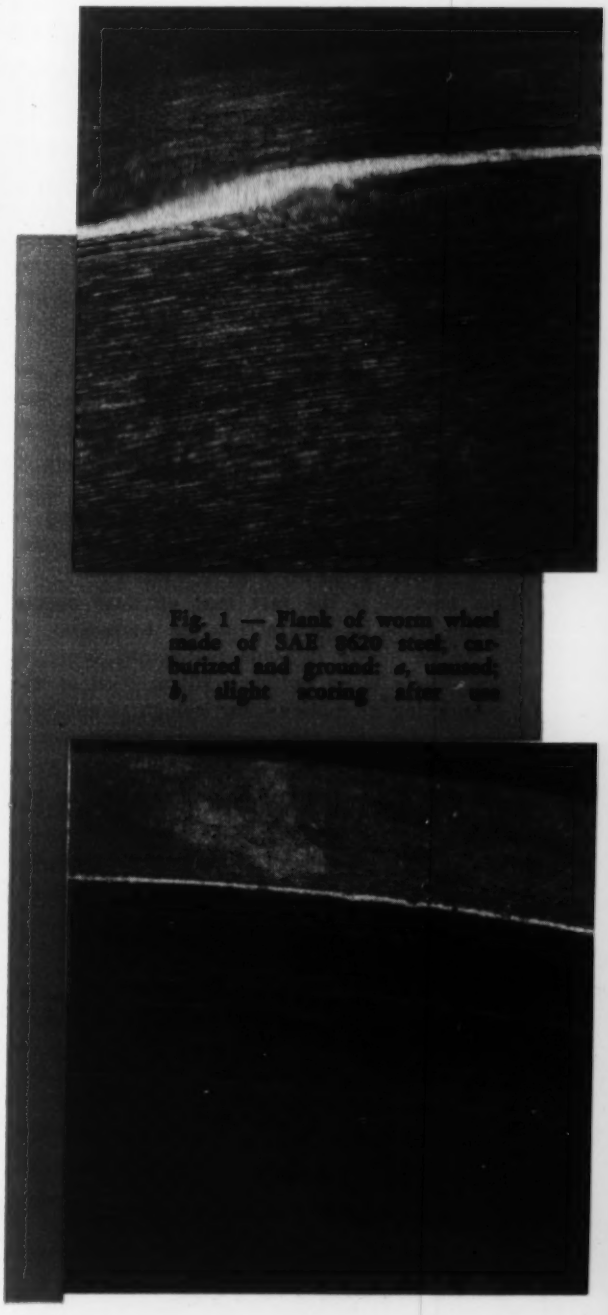

Fig. 1 — Flank of worm wheel made of SAE 8620 steel, carburized and ground: *a*, unused; *b*, slight scoring after use

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condensation of water from the atmosphere due to temperature changes is almost unavoidable and particularly undesirable when the oil contains extreme-pressure additives which can react with water to yield corrosive products.

Lubrication and Cooling Methods: Two additional points of design for maintenance may be properly mentioned: methods of lubrication, and certain design features pertaining to cooling. Both are sometimes not as realistically treated as they should be.

The best design, material selection and manufacture of a gear unit, and use of a perfectly suitable oil, will not safeguard against failure unless the oil reaches the places it has to lubricate in adequate quantity and quality. By "quality", operating viscosity is meant in this context. If the designer had at his disposal a model gear box equipped with windows—just for studying the whereabouts of the lubricant—operating with a transparent lubricant, such as "white" oil or glycerine, he would sometimes be surprised to see where his oil goes actually, in contrast to where one might expect or hope for. Only hints can be given here; more details are given by Merritt[1] and Tuplin[2].

Aside from lubrication by hand or drip feed (practically applied only to open gears), the most common method is lubrication by splash, where the gears pick up the lubricant. Second to this method is application of the oil by jets (circulating system with pump and perhaps oil cooler).

In either of the latter cases, **it should not be taken for granted that enough oil reaches the meshing teeth.** Centrifugal force is one obvious factor militating against the oil staying where it should. Its significance obviously depends on location and shape of the jet, if there is any, and in general on angular velocity of the teeth, their size, and on operating viscosity of the oil.

Less obvious is the fact that oil level during operation tends to deviate from the horizontal. It tends to be higher in some places and lower in others. There is an optimum filling level of the oil considering its motion—low enough to minimize churning losses, but high enough to permit pickup by the gear teeth. Merritt[1] suggests, as a rule, to have the gears dip into the oil three times the depth of the tooth spaces. He also recommends generous proportions of the gear case to provide a large oil volume (less change of level in operation) and reduction of oil drag. In this connection, in a worm gear unit, the immersed position of the worm is preferable to the overhead position.

A somewhat special, but by no means rare, case is that of gear units, mostly worm gears, which make only small and slow movements, such as the steering gears of automobiles. As a rule they are entirely filled with lubricant. If the unit is well sealed, a "multipurpose" gear oil, containing noncorrosive extreme-pressure additives is suitable. If there is a sealing problem, greases are used. A grease very suitable in every respect, would be based on a similar gear oil, almost fluid at room temperature and with about 10 per cent of colloidal graphite added. The graphite performs two functions. In the first place, it serves as a wear-reducing solid lubricant; secondly, it serves as a thickening agent when the lubricant is at rest without seriously impairing its fluidity when motion takes place. This phenomenon, called "thixotropy," deserves to be applied more often in lubrication.

Heat Dissipation: In considering heat production and dissipation, an adequately dimensioned gear casing is the first suggestion. As with internal combustion engines, the oil also functions as a coolant in gear units. In a jet-lubricated unit, an oil cooler can be provided or, generally, water cooling. If no artificial cooling whatsoever is provided, as in most splash-lubricated units, the gear casing is the ultimate unit which dissipates the heat to the surrounding air. The condition of its surface may become significant. Since the condition of the surface can be controlled to offer a minimum resistance to heat dissipation, this subject shall be discussed briefly.

Generally, the surface should not be a heat "barrier." Thus, it should not be covered with a thick coating of a poor heat conductor such as a heavy layer of paint. Secondly, heat emission by radiation should be facilitated. A few data on emissivity (e) will illustrate the point and show the possible gains. Thus, for metallic bright aluminum and its alloys $e = 0.1$ to 0.05; for steel, $e = 0.14$. When surfaces such as aluminum acquire a dull gray appearance by atmospheric action, e may rise spontaneously to 0.95.

The same effect can be accomplished by applying a *thin* coating of a dull (preferably black) finish, firmly adhering to the surface, a thin phosphate coating where feasible, or a coating applied by various other commercial processes. An ideal coating would consist of a dull black semiconductor, such as iron sulphide or silver sulphide, giving both optimum conduction and radiation. The latter kind of surface can be easily produced by electroplating and subsequent anodic sulphurizing. Such measures may be worthwhile where utmost efficiency of a gear unit is imperative.

Experimental Suggestions

Two subjects have experimental aspects enough in common to permit joint treatment: (1) experimentation toward elimination of gear failures, and (2) experimentation toward meeting unusual operating requirements. The most important and most frequent problem common to both cases is overloading, *Fig.* 2, which according to some authors[3] tends to become general practice.

Gear Failures: A prerequisite for the elimination or alleviation of gear failure is the correct diagnosis of its causes. On the basis of AGMA standard 110.01 (with pictures), the subject is discussed in reference 4, and Dudley[5] presents to the

[1]References are tabulated at end of article.

designer an excellent and thorough analysis.

As in other machine failures attributed to the lubricant, careful examination of a gear failure, of the machine where it occurred, and of the machine's operating conditions will often reveal faulty design or manufacture as the real causes. Thus, these two items have to be checked along with inspection of the damaged gear. The latter should be compared with the pictures of AGMA standard 110.01. Such comparison, an inspection of the oil for wear particles, and preferably a check of its viscosity, should yield a clue as to the most probable cause of failure. Some caution in the diagnosis is recommended since there may be several contributory causes. Finally, a simple inspection for adequate heat dissipation and oil level is in order. Overheating, or an inadequately lubricated and worn bearing, may be the ultimate cause of the gear failure. Necessity and extent of more detailed check of design and manufacture depend on the results of the preceding examination.

If the gear failure cannot be traced to poor design, manufacture, installation or wrong lubrication and maintenance, then the most likely cause is faulty operation, notably overloading, which may be due to various causes[5].

Overloading: The most easily overloaded designs are those with large slide-roll ratios, especially hypoid and worm gears. These are perhaps the only types to which the term "overload" strictly applies; the term "underdesign" might be more appropriate in cases of small slide-roll ratio. The prospects for eliminating or alleviating the ill effects of overloading by means of modifying the lubricant vary accordingly. They also depend decisively on the freedom in the choice of the lubricant.

The basic corrective measures are to use: (1) oils of higher viscosity, to obtain primarily thicker oil films and more fluid lubrication and, more incidentally, smaller boundary friction; (2) oils, or additives, whose dominant characteristic is smaller boundary friction, such as animal or vegetable ("fixed") oils or certain synthetic (ester) additives; (3) EP additives, and (4) solid additives. Bearing in mind that the design is fixed, in general, some sacrifice in performance characteristics will have to be expected, e.g., in efficiency or service life. Above all, the most dangerous hazard of marginal overload operation, rapidly increasing wear (large particles), and destructive failure should be avoided.

Fig. 2—Tooth of worm wheel plastically deformed and cracked by overload

The use of high-viscosity oils needs no further comment, except that installation of a heater may be necessary in case the gears have to start at temperatures where the oil tends to channel. High viscosity is the only alleviating measure against the deleterious effects of vibration and shock loads.

In the use of oils with smaller boundary friction, compounded oils as mentioned in the AGMA specifications and recommended for worm gears can be recognized. Various kinds of such oils as well as additives are commercially available. Straight "fixed" oils (e.g., castor or rapeseed oil, of which the former has been in the past considered the best gear lubricant) are seldom used, because they oxidize too readily, are expensive and are in short supply as compared with petroleum lubricants.

Among EP lubricants today, first choice would be the multipurpose type EP gear oils. They are available under various trade names, and the 140 and 250 grades combine high viscosity, low boundary friction and EP properties. The great demand of the automotive industry assures continuous development of the quality of this type of oil. Since, however, the EP function is a chemical one and since EP lubricants are primarily formulated to lubricate steel rubbing against steel, it should not be taken for granted that they will perform equally well with other metal combinations.

The additives of concern in this section are, like the components of "fixed" oils and unlike hydrocarbons, electrically asymmetric, polar molecules. As a rule, their presence in an oil results in finer and more gradual wear in boundary lubrication.

The fourth corrective measure against the ill effects of overloading by predominance of boundary lubrication—the use of solid additives—obviously yields the most nearly positive separation of solid surfaces. It is particularly indicated when a low-viscosity lubricant has to be used in order to encompass a wide temperature range of operation. In order to minimize sedimentation, an antisedimentation (detergent) additive should be included. The use of a suspension of the solid additive in the lubricating oil proper may be supplemented by a film of the solid, bonded to the gear. Even as this film wears off in some places, the remainder assists in holding oil close to wearing areas.

The measures suggested, singly or combined, will at least retard or alleviate gear failures. One kind of failure which practically defies correction by

such measures is plastic deformation of the metal, *Fig.* 3. A stronger material is the only answer.

Appraising Experimental Results: Visual examinations of gears after test runs and comparison with the illustrations of AGMA standard 110.01 is one obvious way of evaluating tests. It may be rather time-consuming, and it is not the only way. A more quantitative method is measurement of operating temperature and efficiency of the unit, *Fig.* 4, supplemented, as a matter of course, by visual observation.

Generally, excessive temperature of the oil and low efficiency will indicate frictional losses. Suppose that, under otherwise identical conditions, two oils of the same type* but different viscosity show roughly the same temperature rise or efficiency loss in the unit. Then thin-film boundary friction, abrasion, or plastic deformation of the metal is causing the loss, not viscous friction. Experiments of this kind with oils of different viscosity and with variation of the oil level will also show any significant churning losses.

The next step would be standardization of the efficiency level attainable under favorable conditions. A simple way of doing this is to adhere strictly to AGMA oil specifications, apply low loads and determine efficiency at low and high speed. High speeds favor hydrodynamic lubrication.

One general rule should be observed in experimentation with overloaded gears: the more severe the overload, that is, the greater the contribution of nonfluid boundary friction, the greater should be the precision of design and manufacture of the unit. Neglect in that respect will almost certainly jeopardize the most careful experimentation.

*By "the same type" is meant, for example, an oil from the same crude, that underwent the same process of refining and contains the same amount and kind of additives, if there are any.

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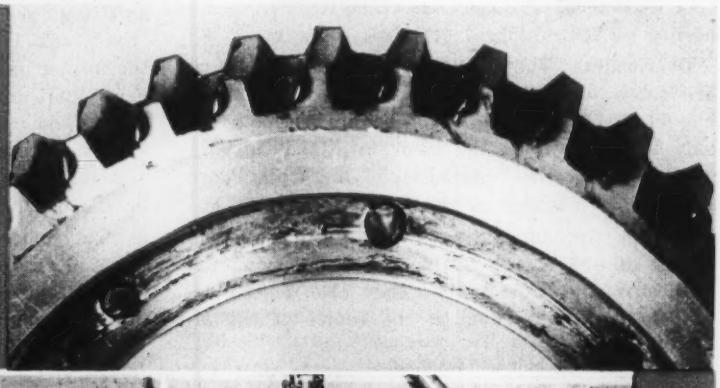

Fig. 3—Plastic deformation of worm wheel caused by overload

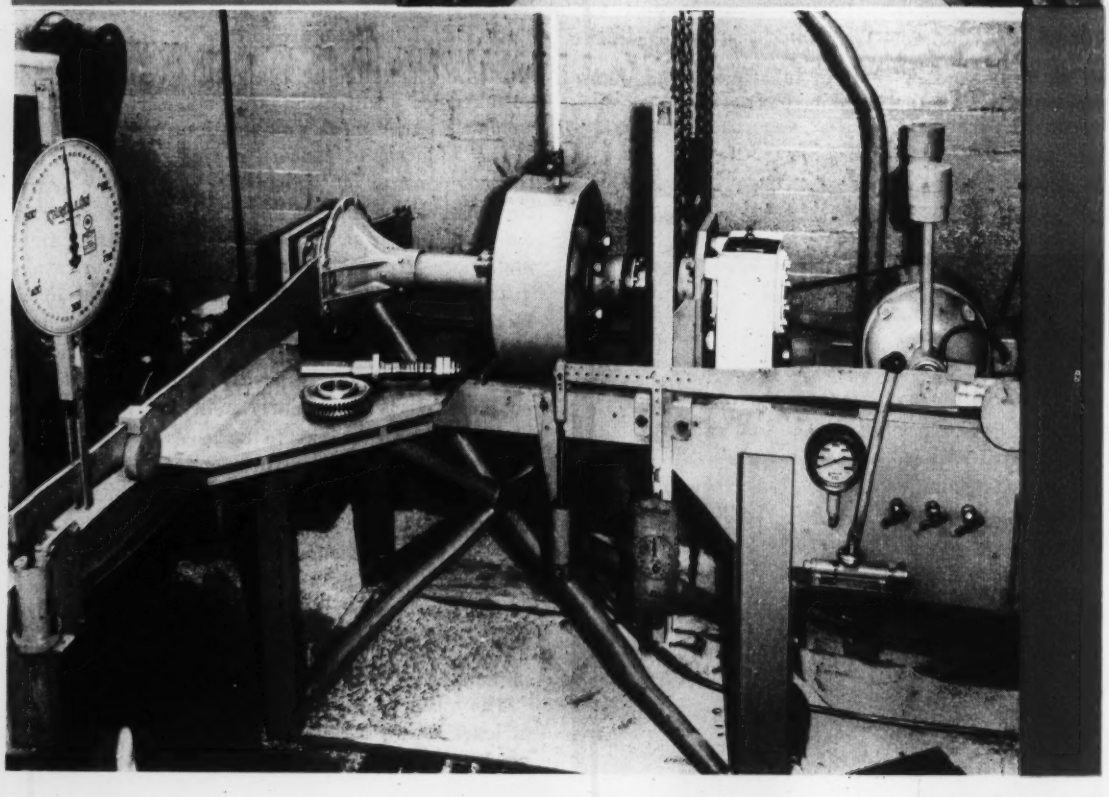

Fig. 4—Typical gear test stand (double dynamometer) used by Vard Inc. for measurement of gear efficiency

MACHINE DESIGN
Data Sheet

Charts simplify design of Cycloidal-Motion Cams

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IN CAM design, so-called cycloidal motion is generally considered best for rapid transfer of machine elements from one position to another where no limitation is placed on the intermediate positions. The cycloidal form is frequently favored because it has a finite rate of change of acceleration at all points. This article presents a cycloidal cam chart for use in quick development of data for actual cam production.

Basic Calculations: To machine a cycloidal cam, a table of values of throw must be prepared so that a master cam can be produced on a jig borer. Values of throw may be calculated from

$$t = \frac{Tn}{N} - \frac{T}{2\pi} \sin\left(\frac{360n}{N}\right)$$

where N = total angle for the rise or drop, deg; T = total throw, in.; n = angle to any point from the starting point, deg; t = throw to any point n deg from the starting point, in.

Calculation of values of t from the equation is laborious and time-consuming. Data for the cycloidal profile, *Table* 1, have been compiled to eliminate these long calculations.

Consider the case where N = 100 deg and T = 1 in. The equation for a cycloid becomes:

$$t = 0.01n - 0.1591549 \sin(3.6n)$$

It is from this equation that *Table* 1 was computed to give values for every 0.1-per cent of rise or drop for a total throw of 1 in. For any other throw, the values are determined by multiplying the total throw required by the appropriate values in the table. First differences, Δ, have been included in *Table* 1 for ease of interpolation where available indexing equipment does not permit use of the tabulated percentage values.

Only 50 per cent of the rise is covered by the chart. The remaining points are determined by subtraction of the points already obtained from the total throw. Thus, the cam is "mirrored" about the midpoint of the rise, *Fig.* 1.

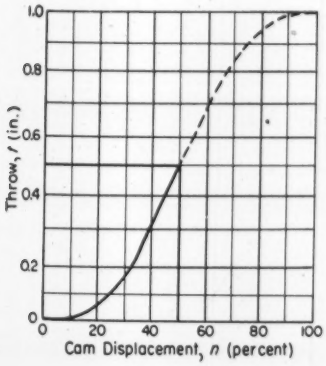

Fig. 1—Basic cycloidal cam motion. Data in *Table* 1 covers range shown solid

Cam Design Example: Assume a cam is to be produced with a cycloidal profile giving total angle of rise N = 120 deg and total throw T = 12 in. If the master cam blank has a maximum radius of 18 in. and a machining cut of 4 in. diam is to be used, it can readily be shown by the law of cosines that the excess metal between cuts will be about 0.0018-in. high when cuts are made every 0.5-deg, or 0.417 per cent, interval. If 0.0018-in. is not considered an excessive amount to file off the master cam, then this cut interval will be satisfactory.

For simplicity in data interpolation, it will be assumed that cuts are to be taken at every 0.48 deg, or 0.4 per cent, interval. Typical calculated values of throw for this cam are given in *Table* 2. Percentage points are taken from *Table* 1, and t is the product of the corresponding table value and the 12-in. throw. Values beyond the 50 per cent point are determined by subtraction of the values already obtained from the total throw of 12 in.

Calculated values may be readily checked by simply determining the first and second difference for the tabulated throw values. Even a slight error in the table will produce a marked deviation in the regular variations of the second differences. These second difference values are significant because they show the variation in the second derivative of the cam displacement curve and, thus, in the rate of change of acceleration produced by the cam profile. For effective high-speed cam action, there should be no marked deviation in the rate of change of acceleration. Therefore, the foregoing method of checking calculations offers a reliable basis for design evaluation of high-speed cycloidal cam profiles.

Table 1—Basic Design Data for Cycloidal Motion

n	t	Δ	n	t	Δ	n	t	Δ	n	t	Δ	n	t	Δ	n	t	Δ
0.0	0.000000	..	10.0	.006450	189	20.0	.048634	688	30.0	.148634	1306	36.7	.248949	1669	43.4	.369876	1914
.1	.000000	0	.1	.006643	193	.1	.049328	694	.1	.149946	1312	.8	.250622	1673	.5	.371793	1917
.2	.000000	0	.2	.006840	197	.2	.050029	701	.2	.151264	1318	.9	.252300	1678	.6	.373712	1919
.3	.000000	0	.3	.007041	201	.3	.050736	707	.3	.152588	1324				.7	.375633	1921
.4	.000000	0	.4	.007245	204	.4	.051449	713	.4	.153918	1330	37.0	.253982	1682	.8	.377556	1923
.5	.000000	0	.5	.007453	208	.5	.052167	718	.5	.155254	1336	.1	.255668	1686	.9	.379482	1926
.6	.000001	1	.6	.007665	212	.6	.052890	723	.6	.156596	1342	.2	.257359	1691			
.7	.000002	1	.7	.007880	215	.7	.053619	729	.7	.157944	1348	.3	.259055	1696	44.0	.381410	1928
.8	.000003	1	.8	.008099	219	.8	.054355	736	.8	.159297	1353	.4	.260755	1700	.1	.383341	1931
.9	.000005	2	.9	.008323	224	.9	.055097	742	.9	.160656	1359	.5	.262460	1705	.2	.385275	1934
												.6	.264169	1709	.3	.387211	1936
1.0	.000007	2	11.0	.008551	228	21.0	.055846	749	31.0	.162021	1365	.7	.265883	1714	.4	.389149	1938
.1	.000009	2	.1	.008782	231	.1	.056601	755	.1	.163392	1371	.8	.267601	1718	.5	.391089	1940
.2	.000011	2	.2	.009017	235	.2	.057361	760	.2	.164769	1377	.9	.269323	1722	.6	.393031	1942
.3	.000014	3	.3	.009256	239	.3	.058127	766	.3	.166152	1383				.7	.394975	1944
.4	.000018	4	.4	.009500	244	.4	.058899	772	.4	.167541	1389	38.0	.271050	1727	.8	.396921	1946
.5	.000022	4	.5	.009749	249	.5	.059678	779	.5	.168935	1394	.1	.272782	1732	.9	.398869	1948
.6	.000027	5	.6	.010002	253	.6	.060463	785	.6	.170335	1400	.2	.274518	1736			
.7	.000032	5	.7	.010258	256	.7	.061254	791	.7	.171741	1406	.3	.276258	1740	45.0	.400819	1950
.8	.000038	6	.8	.010518	260	.8	.062052	798	.8	.173153	1412	.4	.278002	1744	.1	.402771	1952
.9	.000045	7	.9	.010782	264	.9	.062856	804	.9	.174570	1417	.5	.279749	1747	.2	.404725	1954
												.6	.281500	1751	.3	.406680	1955
2.0	.000053	8	12.0	.011050	268	22.0	.063666	810	32.0	.175993	1423	.7	.283256	1756	.4	.408637	1957
.1	.000061	8	.1	.011323	273	.1	.064481	815	.1	.177422	1429	.8	.285017	1761	.5	.410597	1960
.2	.000070	9	.2	.011601	278	.2	.065302	821	.2	.178856	1434	.9	.286782	1765	.6	.412559	1962
.3	.000080	10	.3	.011883	282	.3	.066129	827	.3	.180295	1439				.7	.414522	1963
.4	.000091	11	.4	.012169	286	.4	.066963	834	.4	.181740	1445	39.0	.288551	1769	.8	.416486	1964
.5	.000103	12	.5	.012460	291	.5	.067803	840	.5	.183191	1451	.1	.290323	1772	.9	.418452	1966
.6	.000116	13	.6	.012755	295	.6	.068650	847	.6	.184648	1457	.2	.292099	1776			
.7	.000130	14	.7	.013055	300	.7	.069503	853	.7	.186111	1463	.3	.293880	1781	46.0	.420420	1968
.8	.000145	15	.8	.013359	304	.8	.070362	859	.8	.187579	1468	.4	.295665	1785	.1	.422389	1969
.9	.000161	16	.9	.013668	309	.9	.071228	866	.9	.189053	1474	.5	.297453	1788	.2	.424360	1971
												.6	.299245	1792	.3	.426332	1972
3.0	.000178	17	13.0	.013982	314	23.0	.072100	872	33.0	.190532	1479	.7	.301041	1796	.4	.428306	1974
.1	.000196	18	.1	.014300	318	.1	.072978	878	.1	.192017	1485	.8	.302840	1799	.5	.430281	1975
.2	.000215	19	.2	.014622	322	.2	.073862	884	.2	.193507	1490	.9	.304643	1803	.6	.432258	1977
.3	.000236	21	.3	.014949	327	.3	.074752	890	.3	.195002	1495				.7	.434236	1978
.4	.000258	22	.4	.015280	331	.4	.075649	897	.4	.196503	1501	40.0	.306450	1807	.8	.436215	1979
.5	.000281	23	.5	.015616	336	.5	.076552	903	.5	.198009	1506	.1	.308261	1811	.9	.438196	1981
.6	.000306	25	.6	.015957	341	.6	.077461	909	.6	.199521	1512	.2	.310076	1815			
.7	.000332	26	.7	.016303	346	.7	.078376	915	.7	.201038	1517	.3	.311894	1818	47.0	.440178	1982
.8	.000360	28	.8	.016653	350	.8	.079297	921	.8	.202561	1523	.4	.313716	1822	.1	.442161	1983
.9	.000389	29	.9	.017008	355	.9	.080225	928	.9	.204089	1528	.5	.315541	1825	.2	.444145	1984
												.6	.317370	1829	.3	.446130	1985
4.0	.000420	31	14.0	.017368	360	24.0	.081159	934	34.0	.205622	1533	.7	.319202	1832	.4	.448116	1986
.1	.000452	32	.1	.017733	365	.1	.082099	940	.1	.207160	1538	.8	.321038	1836	.5	.450103	1987
.2	.000486	34	.2	.018103	370	.2	.083046	947	.2	.208703	1543	.9	.322877	1839	.6	.452091	1988
.3	.000522	36	.3	.018478	375	.3	.083999	953	.3	.210252	1549				.7	.454080	1989
.4	.000559	37	.4	.018858	380	.4	.084958	959	.4	.211806	1554	41.0	.324720	1843	.8	.456070	1990
.5	.000597	38	.5	.019243	385	.5	.085924	966	.5	.213365	1559	.1	.326567	1847	.9	.458061	1991
.6	.000637	40	.6	.019633	390	.6	.086896	972	.6	.214930	1565	.2	.328417	1850			
.7	.000680	43	.7	.020028	395	.7	.087874	978	.7	.216500	1570	.3	.330270	1853	48.0	.460053	1992
.8	.000725	45	.8	.020428	400	.8	.088858	984	.8	.218075	1575	.4	.332126	1856	.1	.462045	1992
.9	.000771	46	.9	.020833	405	.9	.089848	990	.9	.219656	1581	.5	.333985	1859	.2	.464038	1993
												.6	.335847	1962	.3	.466032	1994
5.0	.000819	48	15.0	.021242	409	25.0	0.090845	997	35.0	.221242	1586	.7	.337712	1865	.4	.468027	1995
.1	.000869	50	.1	.021656	414	.1	.091848	1003	.1	.222833	1591	.8	.339580	1868	.5	.470022	1995
.2	.000921	52	.2	.022075	419	.2	.092858	1010	.2	.224428	1595	.9	.341452	1872	.6	.472018	1996
.3	.000975	54	.3	.022500	425	.3	.093874	1016	.3	.226028	1600				.7	.474014	1996
.4	.001031	56	.4	.022930	430	.4	.094896	1022	.4	.227633	1605	42.0	.343327	1875	.8	.476011	1997
.5	.001089	58	.5	.023365	435	.5	.095924	1028	.5	.229243	1610	.1	.345205	1878	.9	.478009	1998
.6	.001149	60	.6	.023806	441	.6	.096958	1034	.6	.230858	1615	.2	.347086	1881			
.7	.001211	62	.7	.024252	446	.7	.097999	1041	.7	.232478	1620	.3	.348970	1884	49.0	.480007	1998
.8	.001275	64	.8	.024703	451	.8	.099046	1047	.8	.234103	1625	.4	.350856	1886	.1	.482005	1998
.9	.001341	66	.9	.025160	457	.9	.100099	1053	.9	.235733	1630	.5	.352745	1889	.2	.484003	1998
												.6	.354637	1892	.3	.486002	1999
6.0	.001410	69	16.0	.025622	462	26.0	.101159	1060	36.0	.237368	1635	.7	.356532	1895	.4	.488001	1999
.1	.001482	72	.1	.026089	467	.1	.102225	1066	.1	.239008	1640	.8	.358430	1898	.5	.490000	1999
.2	.001556	74	.2	.026561	472	.2	.103297	1072	.2	.240653	1645	.9	.360331	1901	.6	.492000	2000
.3	.001633	77	.3	.027038	477	.3	.104376	1079	.3	.242303	1650	43.0	.362235	1904	.7	.494000	2000
.4	.001712	79	.4	.027521	483	.4	.105461	1085	.4	.243957	1654	.1	.364142	1907	.8	.496000	2000
.5	.001793	81	.5	.028009	488	.5	.106552	1091	.5	.245616	1659	.2	.366051	1909	.9	.498000	2000
.6	.001876	83	.6	.028503	494	.6	.107649	1097	.6	.247280	1664	.3	.367962	1911	50.0	.500000	2000
.7	.001962	86	.7	.029002	499	.7	.108752	1103									
.8	.002051	89	.8	.029507	505	.8	.109862	1110									
.9	.002142	91	.9	.030017	510	.9	.110978	1116									
7.0	.002235	93	17.0	.030532	515	27.0	.112100	1122									
.1	.002331	96	.1	.031053	521	.1	.113228	1128									
.2	.002430	99	.2	.031579	526	.2	.114362	1134									
.3	.002532	102	.3	.032111	532	.3	.115503	1141									
.4	.002637	105	.4	.032648	537	.4	.116650	1147									
.5	.002745	108	.5	.033191	543	.5	.117803	1153									
.6	.002856	111	.6	.033740	549	.6	.118963	1160									
.7	.002970	114	.7	.034295	555	.7	.120129	1166									
.8	.003086	116	.8	.034856	561	.8	.121302	1173									
.9	.003205	119	.9	.035422	566	.9	.122481	1179									
8.0	.003327	122	18.0	.035993	571	28.0	.123666	1185									
.1	.003452	125	.1	.036570	577	.1	.124856	1190									
.2	.003580	128	.2	.037153	583	.2	.126052	1196									
.3	.003712	132	.3	.037741	588	.3	.127254	1202									
.4	.003847	135	.4	.038335	594	.4	.128463	1209									
.5	.003985	138	.5	.038935	600	.5	.129678	1215									
.6	.004126	141	.6	.039541	606	.6	.130899	1221									
.7	.004270	144	.7	.040152	611	.7	.132127	1228									
.8	.004417	147	.8	.040769	617	.8	.133361	1234									
.9	.004567	150	.9	.041392	623	.9	.134601	1240									
9.0	.004720	153	19.0	.042021	629	29.0	.135846	1245									
.1	.004877	157	.1	.042656	635	.1	.137097	1251									
.2	.005038	161	.2	.043297	641	.2	.138355	1258									
.3	.005202	164	.3	.043944	647	.3	.139619	1264									
.4	.005370	168	.4	.044596	652	.4	.140890	1271									
.5	.005541	171	.5	.045254	658	.5	.142167	1277									
.6	.005716	175	.6	.045918	664	.6	.143449	1282									
.7	.005894	178	.7	.046588	670	.7	.144736	1287									
.8	.006076	182	.8	.047264	676	.8	.146029	1293									
.9	.006261	185	.9	.047946	682	.9	.147328	1299									

Table 2—Typical Cam Design Calculations

n (per cent)	n (deg)	t (in.)	First diff.	Second diff.
0.0	0.00	0.0000	...	...
0.4	0.48	0.0000	0	...
0.8	0.96	0.0000	0	0
1.2	1.44	0.0001	1	1
1.6	1.92	0.0003	2	1
2.0	2.40	0.0006	3	1
2.4	2.88	0.0011	5	2
2.8	3.36	0.0017	6	1
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
48.8	58.56	5.7121	958	0
49.2	59.04	5.8080	959	1
49.6	59.52	5.9040	960	1
50.0	60.00	6.0000	960	0
50.4	60.48	6.0960	960	0
50.8	60.96	6.1920	960	0
51.2	61.44	6.2879	959	1
51.6	61.92	6.3837	958	1
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
98.8	118.56	11.9999	2	1
99.2	119.04	12.0000	1	1
99.6	119.52	12.0000	0	1
100.0	120.00	12.0000	0	0

Applying the Torque Motor

. . . a special motor with a special purpose

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Howell, Mich.

Torque motors are designed primarily to produce torque while stalled across the line. However, the torque motor can also rotate for various periods of time, resulting in a complex duty cycle which must be considered to determine the proper motor. Its characteristics make it suitable for the operation of many devices, such as doors, gates, valves, dampers, reels and tension controls.

Practically all self-starting electric motors are momentarily stalled across the line and the name torque motor is rightly applied only when the locked service is emphasized by a definite duty cycle which is a part of the motor rating. Thus, a motor designed for rapid reversing service, or one which drives a machine until it stalls and is immediately disconnected from the line, is not considered a torque motor.

The purpose of the torque motor is to apply a certain torque at zero speed for a specified period of time and to rotate with lesser torque. In some applications a torque motor, may not be required to rotate or it may never be stalled, but it is capable of doing both.

Applications: Torque motors are used for positioning and holding work in a machine while some operation such as drilling or milling is being performed. A few years ago dc motors were employed for this purpose in conjunction with an electronic controller that reduced the armature voltage during the stalled period. The ac motor is much simpler and is more economical to control.

Torque motors are used to open and close certain types of doors, such as elevator and store doors controlled with an electronic eye. In these cases motion is limited in both directions, and the holding period depends on traffic conditions.

Torque motors are also utilized to control valves, gates, dampers and similar mechanisms. In these applications the power is frequently disconnected after the operation has been performed. Where a number of valves, etc., are to be opened and closed according to some sequence, the power usually remains on until the entire cycle is completed. Also, there are applications in the control of air or liquid where valves or dampers are operated almost continuously, and the power is never removed.

Other applications include driving take-up rolls, maintaining proper tension from pay-off reels, remote control clutches, and operation of various mechanisms. Some of these take advantage of the fact that torque varies as the square of the voltage and incorporate voltage control for this purpose, while others operate only at line voltage.

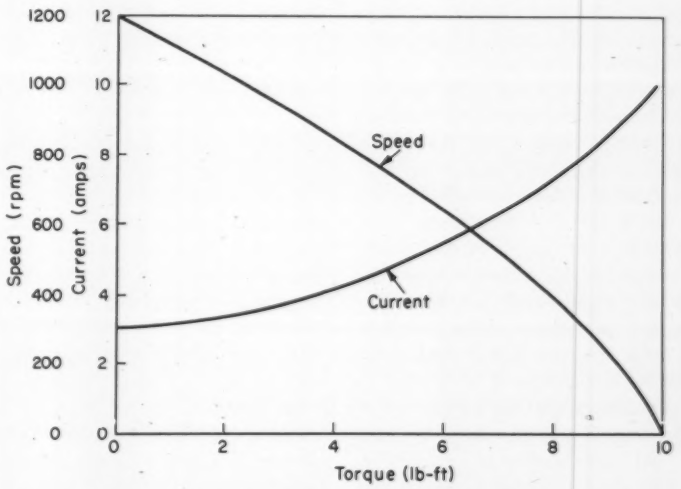

Fig. 1—Typical torque-motor characteristics

Speed - Torque Characteristics: The speed-torque relationship of a torque motor is sometimes referred to as a "quadrant" or a "straight line," although actually it is a cross between them. Such motors are built with high resistance rotors to obtain maximum stalled torque and to limit the locked-rotor current and its attendant heating, *Fig.* 1.

Comparison of a torque motor with a standard NEMA Design B motor having the same locked torque is shown in *Fig.* 2. Note that for the purpose of this comparison locked torque and not the full-load torque of the standard motor has been taken as 100 per cent.

The speed-torque characteristic is such that the motor speed is determined by the resistance offered by the load. Motor speed is always as fast as the load will permit. Sometimes a torque-motor application has a torque characteristic similar to that of a Design B motor. Such a motor can be built, but because of the much greater heat losses which occur in such a design when locked, both the frame size and cost would be much larger than for a conventional torque motor.

Efficiency: The term "torque efficiency" is sometimes used in discussing torque motors. This is the torque per line ampere at any specified voltage and simply indicates how much torque is developed for a given input. The greater the number of poles the greater the torque efficiency, but the slower the synchronous speed of the motor and the slower it will run at any torque less than stalled. As the number of poles is increased the torque is increased while the electrical input and synchronous speed are decreased. The theoretical limit is zero input and zero speed, or a permanent magnet.

A consideration of torque efficiency would indicate size, weight and cost advantages in using the slowest speed motor compatible with the running portion of the duty cycle. However, this is not true with all sizes of motors. Physical limitations of well-designed torque motors restrict fractional horsepower frames to 12 poles and integral horsepower frames through the 25 diameter to 16 poles.

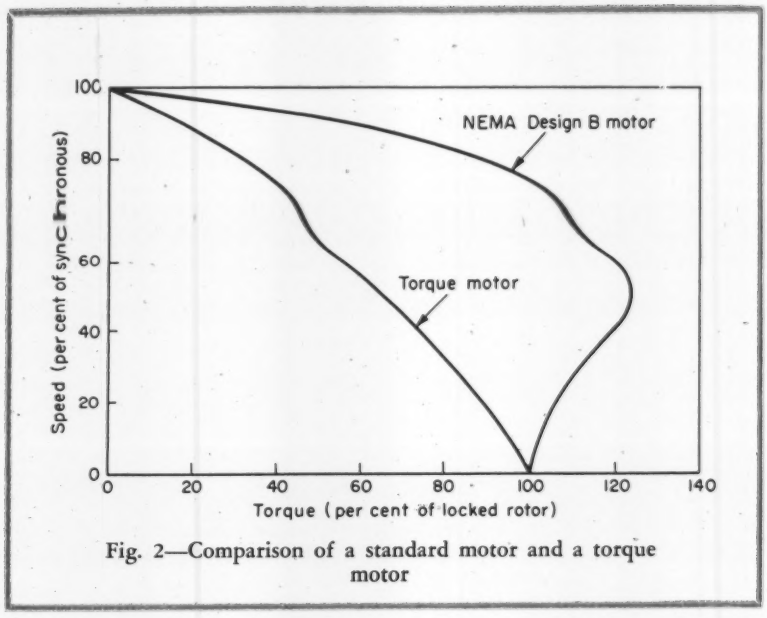

Fig. 2—Comparison of a standard motor and a torque motor

Electrical and Mechanical Ratings: The torque motor is rated according to the torque it produces at locked rotor. It is also rated in synchronous speed or, occasionally, in number of poles. Current ratings of the torque motor, which has no full-load speed other than zero, are given in locked-rotor amperes.

In rare cases it may be necessary to assign a horsepower rating to a torque motor based on some arbitrary speed. When this is done, all nameplate data are given as for a conventional motor plus locked-rotor torque and duty cycle. Such horsepower ratings are usually requested for statistical purposes, such as keeping records of the connected load on a system, but rarely have any meaning so far as the motor itself is concerned. The maximum horsepower rating would occur at approximately half synchronous speed and half torque, but in practice such ratings have been based on 20 per cent of rated locked-rotor torque or occasionally 40 per cent. The 20 per cent value is better since it gives a lower value of horsepower and a higher speed. With a 40 per cent base the slip is about 25 to 30 per cent, and this gives a full-load speed which does not accurately indicate the synchronous speed for motors having more than four poles. In either case the nameplate data will show a high locked kilovolt-ampere per horsepower value, and this may bring about questions from those who are not familiar with torque motors. The use of horsepower or so-called full-load speed ratings on torque motors is strongly discouraged.

The locked-rotor torque is proportional to the square of the voltage. This is true of any conventional motor under locked conditions but is particularly important in the case of the torque motor because it is designed to operate locked, not merely to start and accelerate the load. Hence, it is not practical to rate a torque motor for any voltage except its specific design value.

Thermal Rating: Torque motors are rated by their stalled time. If the motor is allowed to rotate, it can be operated for a somewhat longer period of time than is indicated on the nameplate, but the complexity of the many combinations possible makes a combination "stalled-running" rating impractical. Open motors are rated for 50 C temperature rise, enclosed motors 55 C. Auxiliary ventilation is sometimes used with the larger frames to increase their locked

time.

There is a rule-of-thumb known as the "50 per cent rule" that says if the motor is operated at least 50 per cent of the time at 50 per cent or more of synchronous speed, the short time rating may be increased 50 per cent. This generality is probably on the safe side for an open motor, about right for a totally-enclosed fan-cooled motor, and on the undesirable side for a totally-enclosed nonventilated motor; the latter does not dissipate heat much better when running than when stalled, although it does generate less.

There is another "rule" for applying motors to more or less continuous rotating cycles. Namely, a torque motor can be run continuously at a speed such that the slip in per cent is not greater than the locked duty service in minutes. This cannot be applied when the locked rating exceeds 60 minutes.

Both of the above "rules" are generalities. Manufacturers do not design their motors to comply with these so-called rules, but they do serve a useful purpose in the preliminary analysis of an application. In the smaller frames and slow speeds the exciting current may be a substantial component of the running current. For example, a 12-pole motor in a 56 frame shows 0.34-ampere of no-load current and 0.50-ampere locked, whereas a 4-pole motor in a 254 frame shows 22 amperes no-load and 103 amperes locked. Hence, a rule that is conservative when applied to a 4-pole integral-horsepower frame motor may be unsatisfactory when applied to a multipole fractional-horsepower frame because the copper losses are not reduced in the same proportions.

Overload Protection: It is quite simple to provide overload protection for torque motors. If the motor has a continuous rating, it requires no protection since it can be stalled across the line continuously. For an intermittent rating a heater should be selected that will trip the starter in the specified time at the locked-rotor current shown on the nameplate, such as 30 minutes if the motor has a 30-minute rating. No consideration need be given to the running current. Since the tripping characteristic of overload relays varies considerably with different manufacturers, and relays are not calibrated in "time," the control manufacturer usually should select the proper heater with the foregoing information.

A "compensated" type of overload relay is recommended. This relay is independent of room temperature. If a standard type of thermal overload relay is used, variations in room temperature may cause a change in tripping time and this in turn a change in motor temperature greater than the change in the ambient. While this condition exists with all motors it is especially germane in the case of torque motors which are being protected on the basis of a duty cycle rather than a current overload. Automatic resetting relays are not recommended if a two-wire automatic control is used.

Conductor size and branch circuit protection should be based on the locked current as though the torque motor were not a motor. In other words, the rules governing an "individual motor branch circuit" are not applicable to a torque motor.

From a paper entitled "The Torque Motor — A Special Motor with a Special Purpose" presented at the AIEE Conference on the Application of Motors to Space Heating and Cooling Equipment in St. Louis, Mo., October, 1955.

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Lighter weight, lower cost are factors for designing

Large Plastic Covers

By R. C. Johnson and J. W. Sawyer

Bureau of Ships
Department of the Navy
Washington, D. C.

THE Bureau of Ships has recently installed a plastic cover, of sandwich type construction, with polyester shell and cellular cellulose acetate core, *Fig.* 1, on a propulsion reduction gear case, *Fig.* 2, of the USS *Fitch,* DMS25. This cover is a nonstrength member of the gear case but is expected to withstand the usual treatment its steel counterpart would receive in an engine room.

Weight of conventional steel covers for all propulsion gear cases on a DMS is about 3240 lb. Plastic covers of the type recently installed weigh approximately 996 lb. This results in a weight saving per ship of some 2244 lb or 70 per cent over the steel design.

Lightweight covers offer additional attraction in that they are more easily handled by maintenance personnel. Compare the ease of lifting a 249-lb section of a plastic cover against that of hauling up a section of a steel cover weighing 810 lb. Additional details on weights of various covers are shown in *Table* 1.

Material Specifications: Three different designs were selected for manufacture and tests. They are of the following construction:

1. Single skin glass fiber reinforced polyester resin, *Fig.* 3.
2. Sandwich type, polyester glass laminate shell with cellular cellulose acetate core, *Fig.* 1
3. Single skin modified phenolic resin, reinforced glass fiber, *Fig.* 4.

The object of producing three different covers was to determine the design, methods and materials that would give the best overall performance, *Table* 2.

Materials were required to withstand impingement of lubricating oil without loss of strength or rigidity. They were to be fire resistant to the extent of being self-extinguishing. Resins were to be reinforced with fibrous glass mat or cloth. The resin content was not to exceed 70 per cent by weight. Water and oil absorption was to be insignificant. Resin starved areas, entrapped air or porosity were not permitted.

The core materials were not to absorb more than 0.1-lb of water or oil per sq ft of cut surfaces, when immersed in either for 24 hr. Density was to be less than 12 lb per cu ft.

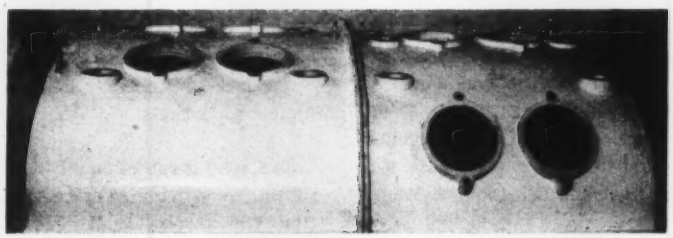


Fig. 1—Gear case cover of sandwich type construction, with polyester glass laminate shell and cellular cellulose acetate core

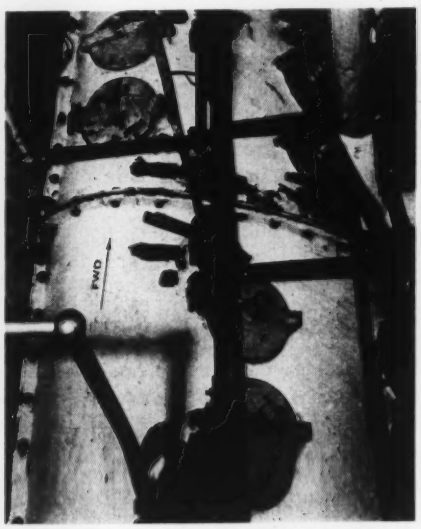


Fig. 2—Plastic gear case cover, sandwich type construction, installed on ship

Table 1—Comparison of Gear Case Covers*

Material	Thickness (in.)	Weight (lb.)
Conventional steel construction	$\frac{3}{16}$	810
Plastic:		
Single skin polyester-glass	0.20-0.35	237
Sandwich construction, polyester, CCA† core	$\frac{13}{16}$	249
Modified phenolic resin	0.20-0.35	250

*Overall dimensions: length 83 in., width 68 in., height 19½ in. †Cellular cellulose acetate.

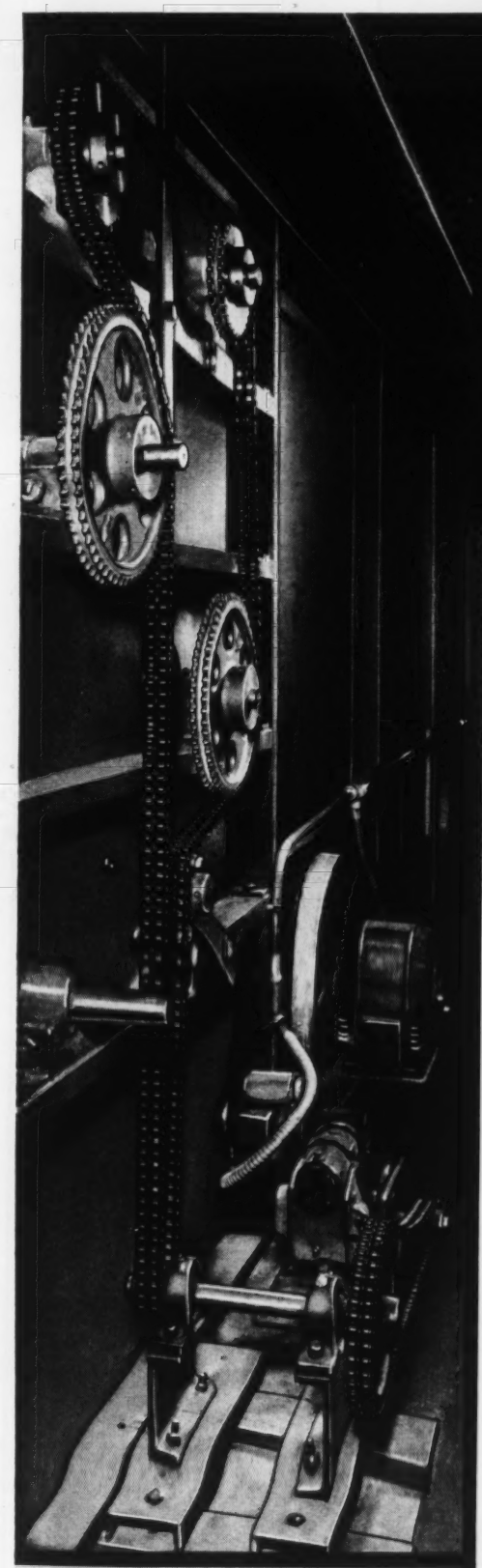
Manufacture and Fabrication: Each cover has the same overall dimensions, *Table* 1, and openings for inspection and thermometers. The reinforcements, style 1000 glass fiber cloth with No. 136 finish, were the same for all three units. Materials and fabrication are described briefly as follows:

1. *Single Skin Construction—Reinforced Polyester Resin* (*Fig.* 3): The resin used was a general-purpose rigid, styrene cross-linked, polyester resin. The method of fabrication was a hand layup of the main portion of the cover to a thickness of 3/16-in. Separate press moldings were made for access-door bosses and temperature-indicator opening bosses. These were then secondarily bonded to the cover as were edge reinforcements. Threaded steel inserts were then installed in the bosses for cover attachments. A T-section stiffener was bonded to the inside surface of the cover, and two similar sections were added to the outside surface when load testing indicated their need. The cover when completed was coated on the outer surface with a fire-retardant compound of antimony oxide and Chlorowax.

Table 2—Structural Properties of Plastic Gear Case Covers*

Property	Polyester-Glass Single Skin	Sandwich Construction Polyester-Glass, CCA Core	Modified Phenolic Resin
Flexural strength (psi)	26,500-30,700	20,000†	19,000
Flexural modulus (psi)	1.54×10^6 to 1.70×10^6†	0.99×10^6	1.10×10^6
Glass content (per cent)	48.5	36.0†	55.5
Flammability	Self extinguishing	Self extinguishing†	Burned completely
Oil resistance	No effect	No effect	No effect
Water absorption (per cent)	0.14-0.27	6.8§	0.62

*Results of physical tests on sample panel. †Properties determined for walls only, without CCA filler. §Water absorption was relatively high but was caused by exposed CCA edges. No such exposed edges exist in gear case cover.



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—ITEM 226—

2. *Sandwich Construction (Fig. 1):* The second cover was a sandwich type construction employing style 1000-136 finish woven reinforcement and general-purpose polyester resin as the inner and outer skins with a 7 lb per cu ft cellular cellulose acetate core.

The inner skin was first premolded on a male form. Then CCA core was tailored to fit the cover contour and bonded to the inner skin with polyester resin as the adhesive. Following this, the outer surface was layed up by hand over the CCA core. Skin thicknesses were ⅛-in. inner and 3/16-in. outer; the core was ⅝-in. thick, for an overall sandwich thickness of 15/16-in. The bosses and edge reinforcements were bonded the same as in the preceding cover. The unusual skin thickness was dictated by the severity of the impact test specified. Bosses for the access doors and temperature-indicator openings were then bonded the same as those for the single skin type.

3. *Plain Construction — Reinforced Phenolic Modified Resin (Fig. 4):* The method for construction of this cover was the same as for the single skin cover. The only exception was that a modified room temperature curing phenolic resin was used instead of the polyester material.

Suggestions for New Designs: As a result of laboratory testing of the three plastic covers, shipyard installation work and limited shipboard experience, the following points are offered for consideration of new cover designs:

The design should be made to fit the material used and not necessarily duplicate the configuration of the steel cover. Add reinforcing as needed to give strength with only secondary concern for appearance.

Install soft gasket, such as neoprene, between flanges of plastic cover and steel case where oil tightness is necessary. Incorporate metal reinforcing or use continuous metal strip with suitable bolt holes instead of single metal washers. Metal reinforcing or continuous strip washer will prevent bowing of flange between bolts.

Drill all bosses and flanges at the time of installation to assure accurate location of bolt holes, thermometer connections and inspection openings. Leave outside diameter of bosses ½-in. oversize where practicable. Design all flanges at least ⅛-in. thicker than corresponding steel parts.

Provide a plastic spacer for center transverse joint to allow for aligning of end flanges.

Advantages: Among the advantages of the plastic cover the following are outstanding:

Weight Reduction: Up to 70 per cent is attained with a saving of 2244 lb per ship.

Ease of Handling: Cover can be lifted or installed with less difficulty.

Noise Reduction: The installed sandwich type cover reduces airborne noise radiating from reduction gear about 5 decibels average and up to 8 db at certain frequencies.

Noncritical Materials: The materials used in manufacture are considered noncritical.

Production Cost: Quantity production should result in a cost that is about 50 per cent of the steel cover.

Noncorrosive: No rusting or corroding occurs as in a steel cover.

From "Plastic Covers for Propulsion Gear Cases on U. S. Naval Ships" in Journal of the American Society of Naval Engineers Inc., *August,* 1955.

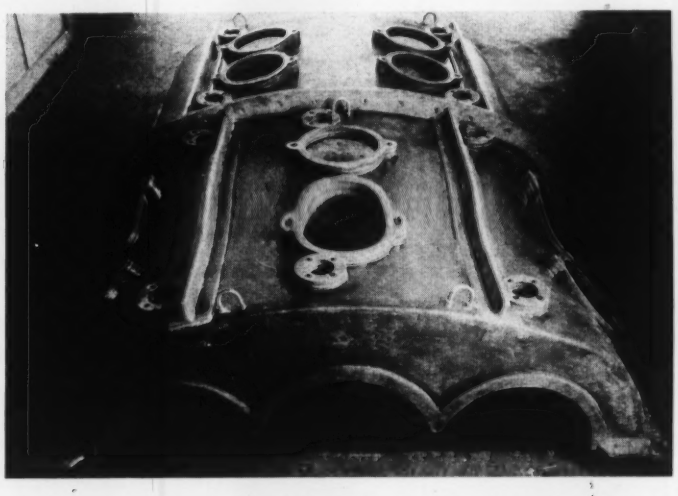

Fig. 3—Single skin glass fiber reinforced polyester resin gear case cover with T-stiffeners added

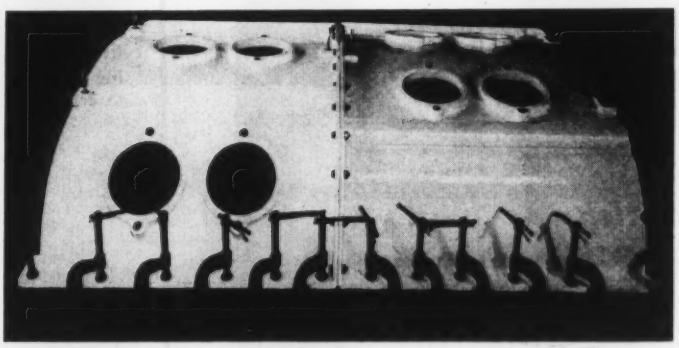

Fig. 4—Single skin modified phenolic resin reinforced glass fiber gear case cover

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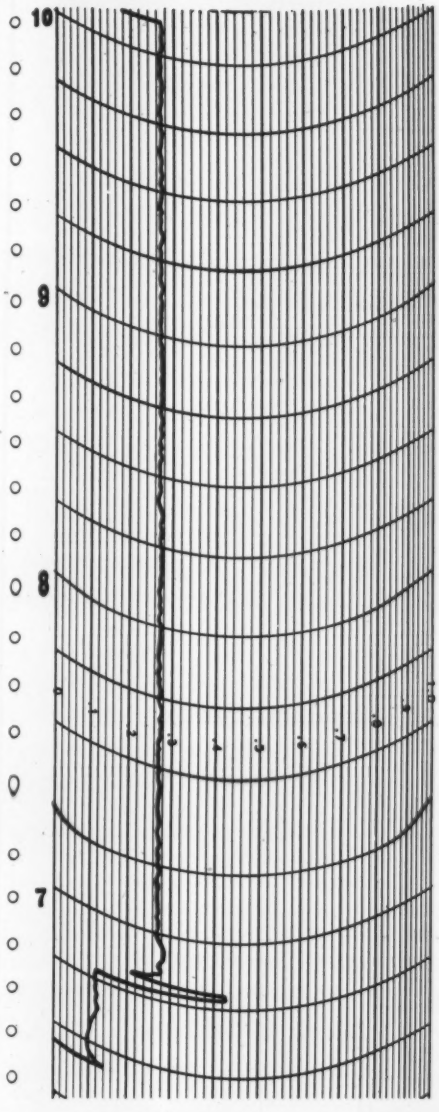

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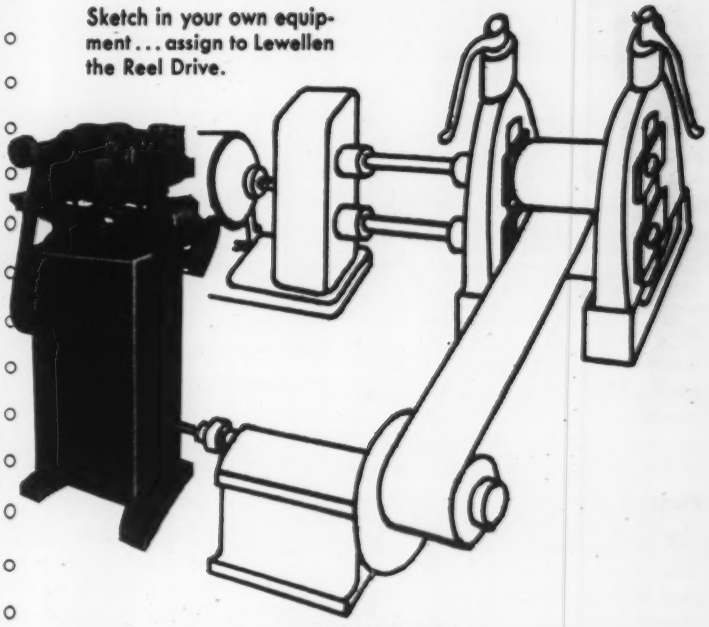

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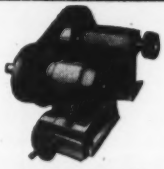

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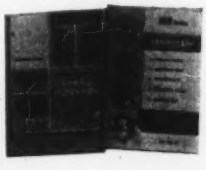

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—ITEM 227—

HELPFUL LITERATURE

for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Beryllium Products

"Berylco Product Directory" lists and describes characteristics of beryllium copper, beryllium aluminum and beryllium nickel alloys; beryllium metal and beryllium oxide; wrought, forged and cast beryllium copper alloys; and beryllium copper safety tools. Products include extruded rod and bar, seamless tubing in redraw sizes and extruded shapes. 20 pages. Beryllium Corp.

—Circle ITEM 1

Plastics & Resins

Technical data on wide range of special and general purpose Bakelite phenolic, vinyl, styrene, polyethylene, fluorothene, polyester, silicone and epoxy plastics and resins, and Krene film and sheeting are found in revised "1956 Condensed Reference File." Over 50 products are covered. 12 pages. Bakelite Co.

—Circle ITEM 2

Roller Chains

"Helpful Hints on Conveying with Rex Roller Chains and Attachments" is an illustrated bulletin (No. 55-11) which shows many stock, made-to-order and special attachments which can be furnished for use with Rex roller chain. 4 pages. Chain Belt Co.

—Circle ITEM 3

Hydraulic Valves

Sixteen different hydraulic valves and their uses in aircraft, industrial and mobile equipment are described in illustrated bulletin 101. Included are timing, speed control, pressure relief, cut-out, selector, check, solenoid and thermal relief types. 4 pages. Electrol Inc.

—Circle ITEM 4

Package Drives

Five cabinet sizes with 5 to 150-hp drive motor range are available in package drive for speed control of machine tools and other applications requiring accurately controlled variable speed over a wide range. Described in illustrated bulletin 51B8166, they feature magnetic amplifier generator field control, preset control for repetitive operations, control of all machine functions from one or more remote points and protection against overload and undervoltage. 8 pages. Allis-Chalmers Mfg. Co.

—Circle ITEM 5

Spray Valve Panels

Self-contained spray valve panels, designed to spray-lubricate bull and girth gears and other spur or herringbone gear trains, are illustrated and described in bulletin No. 26-R. Panels are fastened to gear housings or framework to spray lubricant on pressure side of gear teeth. Data on all Farval centralized lubrication systems are also included. 20 pages. Farval Corp.

—Circle ITEM 6

Electrical Connectors

Electrical and mechanical ratings, mounting and clearance dimensions and diagrams of series GS recangular miniature electrical connectors are found in data sheet. They have side or top opening aluminum hood and 15 contacts for rack and panel or cable mounting. 2 pages. DeJur-Amsco Corp.

—Circle ITEM 7

Control Relays

From 2 to 12 poles are available in sectional-pole heavy duty 10-amp control relays, described in illustrated bulletin PL-7305-PM. Designed to occupy a minimum of panel space, they can have up to eight poles without double-decking. Dimensions, enclosures and technical data are given for each of 10 models. 8 pages. Clark Controller Co.

—Circle ITEM 8

Limit Switches

Application information, ratings, dimensions and prices for lever and rotating cam type limit switches are found in illustrated bulletin GEA-6131A. Included are lever-operated snap action, small oil-tight snap action, lever type double circuit, rotating cam and lever-operated slow make and break switches. 8 pages. General Electric Co.

—Circle ITEM 9

Liquid Filter

Particles down to 40 microns in size can be removed by the Super Auto Klean filter, a continuously cleanable metal edge unit detailed in illustrated catalog SAK-057. It is available in carbon and stainless steel construction with a variety of spacings and capacities. Two-stage filtration is illustrated. 8 pages. Cuno Engineering Corp.

—Circle ITEM 10

Engineered Ceramics

Facilities of this company for producing precision porcelain products are described in illustrated bulletin 955. A ceramics properties chart is included and quality control and production methods are pictured. The prototype service is described. 8 pages. Frenchtown Porcelain Co.

—Circle ITEM 11

Electric Motor Design

Small, light, cool-running series 100 motors in face, flange and foot-mounted styles with standard, open dripproof, sanitary, weather-protected splashproof, and totally enclosed

ures are shown in full color in bulletin N-100-R. Design and performance data are given on polyphase motors ranging in capacity from ½ to 40 hp. 16 pages. Howell Electric Motors Co.

—Circle ITEM 12

Constant-Force Springs

Preliminary design data on Neg'ator constant-force springs as an extension member are presented in illustrated manual 310E. Properties and applications of this new elastic force member are discussed. Spring is a roll of specially formed strip material which exerts a constant restraining force to resist uncoiling. Mounted on a freely turning drum,

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—ITEM 228—

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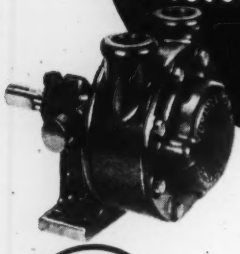


Catalog 105 presents the complete line of Tuthill automatic reversing pumps. Without the use of check valves, these rotary, internal-gear positive displacement pumps can be driven in either direction of rotation without changing direction of flow or port positions.

TUTHILL PUMPS FOR THE PURPOSE

TUTHILL PUMP COMPANY
Dependable Rotary Pumps since 1927
939 East 95th Street, Chicago 19, Illinois

Canadian Affiliate: Ingersoll Machine & Tool Co., Ltd. • Ingersoll, Ontario, Canada

—ITEM 229—

Helpful Literature

it is in effect a constant-force spring having a gradient of zero. 24 pages. Hunter Spring Co., Neg'ator Div.

—Circle ITEM 13

Hose Coupling Data

Complete information on hose couplings and fittings for up to 6-in. steam, air or water hose are presented in illustrated data folder No. 3100. In addition, data are given on Punch-Lok clamps, menders and nipples; inserted and anchor bar nipples for up to 20-in. lines; and related fittings. 4 pages. B. F. Goodrich Co., Industrial Products Div.

—Circle ITEM 14

Lubrication Guidance

Lubrication recommendations for many industrial needs are tabulated on handy wall chart. Such applications as hydraulic systems, air compressors, electric motors, reduction gears, oven conveyors and spindles are covered. E. F. Houghton & Co.

—Circle ITEM 15

Electrical Insulation

Compilation of technical data sheets of Irvington flexible electrical insulation materials contains design information on coated products, varnishes and plastic products. Charts and conversion tables amplify the technical references. Looseleaf binder permits adding or changing data sheets as needed. Minnesota Mining & Mfg. Co., Irvington Varnish & Insulator Div.

—Circle ITEM 16

Polymer Products

The chemical structure, specifications, properties, applications and general description of a new group of fluorocarbon oils, waxes and greases are detailed in bulletin "Kel-F Oils, Waxes and Greases." Use of these corrosion, temperature and pressure resistant polymer products in hydraulic equipment, potting and sealing waxes, damping fluids, heat transfer media, permanent lubricants and many other applications are discussed. 16 pages. M. W. Kellogg Co., Chemical Mfg. Div.

—Circle ITEM 17

Investment Alloys

The 11 x 17-in. "Chart of Standard Investment Casting Alloys" is a comprehensive tabulation covering stainless, low alloy and tool steels, nickel alloys, copper base alloys and aluminum alloys. Chart lists complete

DOW CORNING CORPORATION

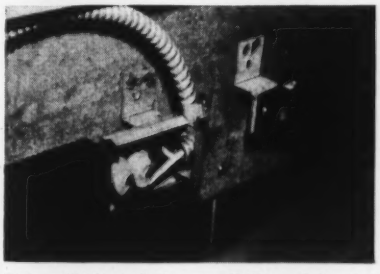
Silicone News

FOR DESIGN ENGINEERS

FAST RELIABLE DEFROSTING WITH SILASTIC INSULATED LEAD WIRE

Take temperatures low enough to preserve frozen foods in an open display case and high enough to defrost the case in a hurry, and you have an ideal climate for Silastic*. Serviceable at temperatures ranging from —100 to 500 F, Silastic insulated lead wire solved the problem of a fast and reliable defrosting system for Tyler Refrigeration Corporation.

Originator and leading producer of open frozen food display cases, Tyler employs high-powered strip heaters for fast, automatic defrosting. Twice daily, temperatures at the terminal connections may jump from a low of —30 F to a high of 212 F and remain there for 30 to 50 minutes at a time. At such temperatures, the organic rubber insulation on conventional lead wire deteriorates rapidly. Unexpected failure could mean the loss of hundreds of dollars worth of frozen foods.



Tyler eliminated the possibility of insulation failure due to high temperatures, and gained Underwriters' approval at the same time, by specifying lead wire insulated with Silastic. In the thousands of frozen food cases that have been put into service since 1951, no lead wire failures have ever been reported.

For extra protection against moisture condensation, Tyler coats the connection between the terminal strip and the bare wire with Dow Corning 4, a non-melting waterproof silicone dielectric compound. *No. 63*

*T.M. REG. U.S. PAT. OFF.

Silastic, the Dow Corning silicone rubber, keeps its shape, stays resilient from —100 to 500 F; resists hot oils and chemicals; withstands weathering ozone and corona; and is an ideal dielectric material. Properties of Silastic are fully detailed in new reference brochure. *No. 64*

OVEN-HOT AIR USED TO COOL SILICONE INSULATED EQUIPMENT

Cool electrical equipment with air that has a temperature of 250 F? Yes you can, providing the equipment is protected with Dow Corning silicone insulation. Here's how Westinghouse engineers put 250 F air to work cooling their new 40 kva, 400 cycle alternators or a-c generators for jet planes.

When a jet plane is hurtling through low altitude atmosphere at the speed of sound, air available for cooling purposes may have a temperature as high as 250 F. Far from cooling organic electrical insulating materials, these high ambients cause them to burn up in short order. At high altitudes, air temperature drops to —70 F, but the air is so thin, it has less heat-absorbing power than at low altitudes.

That's why Westinghouse uses silicone (Class H) insulation in their jet plane alternator. Operable at temperatures in the range of 480 F and higher, the silicone insulation is actually cooled by air hot enough to cause rapid failure of ordinary insulating materials.

To provide maximum cooling effect at any altitude, the Westinghouse alternator is fitted with a cone and hood combination that directs air to the critical pole and rear bearing areas. Because of its exceptional oxidation resistance and thermal stability, Dow Corning 44 Grease is used to lubricate the bearings. *No. 65*

New 1956 Reference Guide to Dow Corning silicone products briefly reviews properties and applications of silicone products most widely used. Indexed by application, this all-new guide will prove a definite aid to design engineers concerned with product improvement and cost reduction. *No. 66*

Pressure Sensitive Silicone Tape 'Welds' Seam in Hot Water Heater

New opportunities for product improvement and production economies have been opened up by the introduction of heat-stable, waterproof tapes made with pressure sensitive Dow Corning Adhesives. Such tape forms a water resistant seal that retains adhesive strength at temperatures from —100 to 550 F. Here's how White Products Corp., Middleville, Mich., replaced a welded joint; saved production time and cut unit costs with such tape.

A leading producer of hot water heaters, White frequently found it necessary to operate their tank plant overtime to meet production demands. One of the most time consuming jobs in the plant was hand welding a combustion-chamber skirt to the base of each heater to comply with American Gas Association requirements for the prevention of flue gas escape.

In 1954, at the suggestion of Mystik Adhesive Products Co., White production men tried sealing this 48-inch seam with a new Mystik tape coated with Dow Corning Adhesive. The seal passed all AGA tests, including constant high fire and surface temperatures in the range of 520 F. With this new tape, White realized material savings amounting to 7c a unit. Production in the tank plant has doubled. *No. 67*

Design Edition 16

DOW CORNING CORPORATION - Dept. 6801
Midland, Michigan

Please send me 63 64 65 66 67

NAME _____

TITLE _____

COMPANY _____

STREET _____

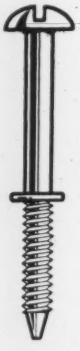
CITY _____ ZONE ___ STATE _____

ATLANTA • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C. (Silver Spring, Md.)

Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris

OFTEN

TWO HEADS ARE BETTER THAN ONE



Sometimes a double-headed part or fastener is the LOWEST COST and FASTEST solution to your assembly problem. This special shown at the left is a good example. Pointed, machine threaded, center collar stop, large drive head with a slot. Make this any way but cold-headed and it would cost a fortune! But HASSALL made it . . . FAST and at LOW COST.

Double-heading is only one example of the almost limitless possibilities Hassall cold-heading offers you. If you have a fastener problem just send us samples or specifications for a quotation.

WRITE FOR CATALOG . . . . . with it we will send you our popular decimal equivalent wall chart. John Hassall, Inc., Box 2197, Westbury, L. I., N. Y.

HASSALL

SINCE 1850

Hassall

NAILS, RIVETS, SCREWS AND OTHER COLD HEADED FASTENERS AND SPECIALTIES

—ITEM 231—

Helpful Literature

chemical analysis and mechanical properties, and rates alloys as to castability, machineability, corrosion resistance, weldability and response to plating. Precision Metalsmiths, Inc.

—Circle ITEM 18

Diesel Engines

Type S and SS heavy duty diesel engines described in bulletin 10,040 range in capacity from 375 to 1000 hp. Design and application data are presented on these solid fuel injection prime movers. 20 pages. Ingersoll Rand Co.

—Circle ITEM 19

Standard Bearing Sizes

Dimensions and ordering numbers for more than 1000 powdered metal commercial bearings are contained in booklet "Standard Bearing Sizes." Application and design information are given on sleeve, flange, double and single hub spherical type bearings and for thrust washers. 32 pages. Keystone Carbon Co., Powdered Metals Div.

—Circle ITEM 20

Copper Base Alloy Rods

A complete range of alloys from standard free-cutting types to specials are subject of engineering manual FM-3010, entitled "Copper Base Alloys in Rod Form." Technical data covers chemical composition, mechanical and physical properties, machinability ratings and suitability for various fabricating processes and uses. 28 pages. Mueller Brass Co.

—Circle ITEM 21

Motors & Generators

Performance and details of construction for the Marathon line of 1/20 to 2500-hp motors and ½ to 2000-kw generators are given in illustrated booklet "A Company With a Future Invites You." Practically any type of construction can be furnished. Marathon Electric Mfg. Co.

—Circle ITEM 22

Oscillographic Recorders

All of company's 150 series oscillographic recording systems, components and associated equipment are described in bulletin No. 1. Basic systems in 1, 2, 4, 6 and 8-channel models, and eleven plug-in preamplifiers are covered. Performance data for these interchangeable front-ends, as well as frequency response char-

Johnson Ledaloyl self-lubricating bearings hold oil like a sponge—will never need oiling for the life of Telectro tape recorders. Here one is being slipped on to the shaft of component.

Accuracy of Ledaloyl bearings makes for snug press-fit in the base plate of Telectro recorder.

A handful of trouble-free service for Telectro—Johnson Ledaloyl bearings assure durability of recorder, yet are economical and easy to install.

For Accuracy, Durability And Economy, Telectro Industries Uses Johnson Ledaloyl Self-Lubricating Bearings

Telectro Industries Corporation of Long Island City, New York, insists that every component of their wire and tape recorders must have the quality and stamina to give trouble-free service for the life of the machine.

That is why they chose Johnson Ledaloyl bearings according to Mr. Roy Yasen, Purchasing Agent, who says: "Everything considered—accuracy, price and delivery—we find these self-lubricating bearings to be the most durable in this price range." "People who buy these recorders won't be bothered with taking them apart to oil bearings," continues Mr. Yasen, "that's why we use Johnson Ledaloyl bearings, that have the oil right in them. They last as long as the machines, without lubrication."

A Johnson distributor services Telectro, gives them immediate delivery on stock sizes, calls in a Johnson field engineer to help work out any special items.

Your local Johnson distributor has available more than 400 stock sizes in three basic types—he will be glad to work with you in developing new economy and performance in the items you manufacture. Johnson Bronze Company, 525 South Mill Street, New Castle, Pennsylvania.

Johnson Bearings

GRAPHITED
over 175 sizes

GENERAL PURPOSE
over 900 sizes

UNIVERSAL BRONZE BARS
over 400 sizes

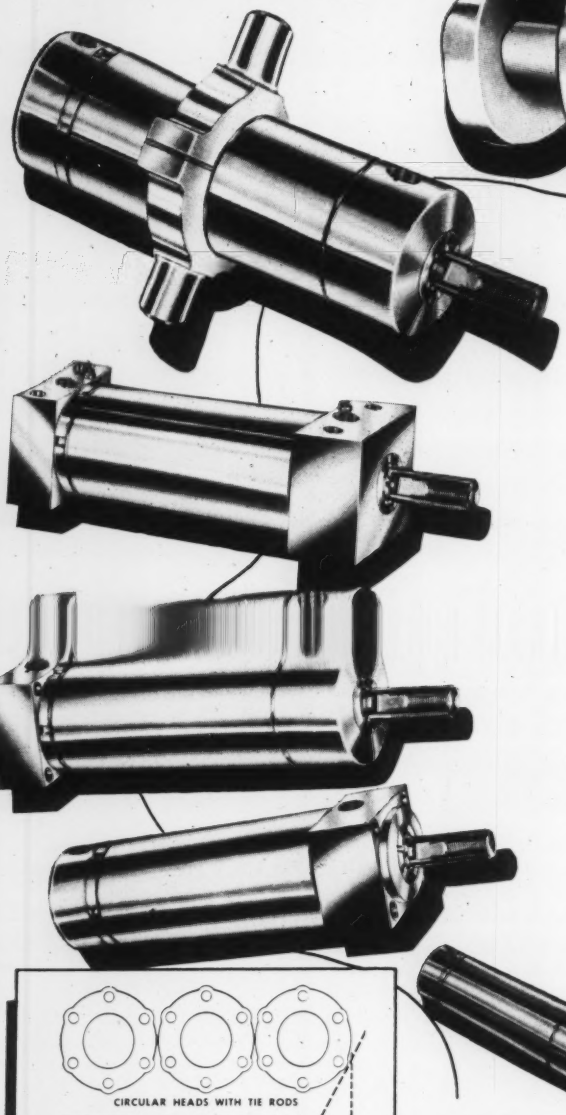
LEDALOYL
over 400 sizes

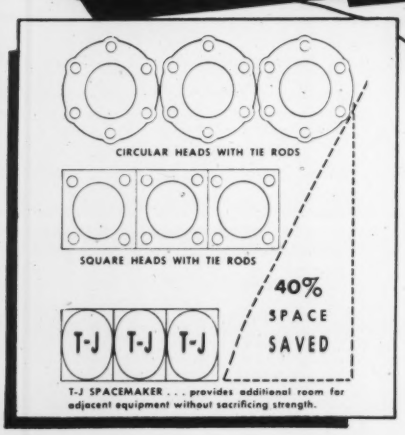
ELECTRIC MOTOR
over 350 sizes

—ITEM 232—

DELIVERY OFF THE SHELF©

IN 64,000 COMBINATIONS





T-J

Spacemaker

CYLINDERS

OUTMODE ALL OTHERS
SAVE 40% SPACE!

You'll never go back to tie-rod cylinders, once you apply T-J Spacemakers to your push-pull-lift jobs! Advantages in space saved, weight saved, greater strength and off-the-shelf delivery are among the dozens of Extras you get as Standard!

Now — these sensationally popular T-J Spacemaker Cylinders are available off the shelf *in sizes up to 8″*. This means as many as 64,000 different combinations of styles, bores, strokes, mountings, etc. *immediately available!* Oil pressure to 750—Air to 200 P.S.I. Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion. Hard chrome plated bodies and piston rods (Standard). Only from T-J can you get these new ingenious cushion designs! Send for bulletin SM-155-2. The Tomkins-Johnson Co., Jackson, Mich.

See us in Fluid Power Area ASTE Show Booth 225

Member of the National Fluid Power Association

T-J TOMKINS-JOHNSON

RIVITORS...AIR AND HYDRAULIC CYLINDERS...CUTTERS...CLINCHORS

—ITEM 233—

acteristics of galvanometer with driver amplifier are also provided. 16 pages. Sanborn Co., Industrial Div.

—Circle ITEM 23

Bearing Design

Metermatic prelubricated bearing design used on this company's alternating and direct current motors is described in bulletin A-2406. Design features metering plate that automatically regulates grease flow to bearing and provides pressure relief against over-greasing. 4 pages. Reliance Electric & Engineering Co.

—Circle ITEM 24

Drafting Templates

Sixty-four drafting templates for engineers, draftsmen, architects and designers are listed in illustrated catalog No. 57. They include 13 for general use, 8 ellipse and 8 mechanical engineering templates, 4 processing and 8 electrical templates, 12 architectural and 6 specialized templates. 12 pages. Rapidesign, Inc.

—Circle ITEM 25

Snap-Action Thermostats

Adjustable, nonadjustable and manual-reset styles of the Stemco snap-action thermostats are covered in bulletin L-6397-A. It describes operating principles and includes information on performance, ratings, dimensions, construction details and various mounting arrangements. 2 pages. Stevens Mfg. Co.

—Circle ITEM 26

Ball Bearing Screws

Comprehensive catalog contains latest information on machine-ground ball bearing screws, rolled-thread ball bearing screws and ball bearing splines. Last item represents an advance in application of ball bearings in an area previously dominated by sliding members. 32 pages. General Motors Corp., Saginaw Steering Gear Div.

—Circle ITEM 27

Screw Machine Products

Easy-to-use table for estimating weight of High-Speed free-cutting brass rod required for screw machine products fabrication is featured in this folder. Table gives "pounds per 1000 pieces per inch" for round, square and hexagon rod in all commonly used diameters from 1/16 to 3½ in., as well as figures for "pounds per linear foot." Weight conversion

specify IRIDITE

AN-C-170 MIL-S5002 MIL-C-5541 AN-P32 AMS-2402A USA-50-80-11A J.Q.D. No. 144B USA 57-93-2A O.S. No. 1374 USA 57-0-2C AN-P61 A-XS-1607 QQ-P-416 QQ-Z-325 MIL-3151— if you're finishing under these or similar specifications, here's how you can use Iridite:

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER . . . Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004 06 E MONUMENT STREET • BALTIMORE 5 MD

—ITEM 234—

SHIMS

BRING YOUR SHIM PROBLEMS TO EXPERIENCED SPECIALISTS

•

Only LAMINATED SHIM COMPANY Offers These Efficient, Economical Solutions:

THE **LAMINUM®** SHIM

SIMPLY PEELS FOR ADJUSTMENT

Made up of from 3 to 63 layers of .002 or .003 inch brass or steel, metallically bonded together over their entire surfaces. No dirt between layers. Peels with penknife.

THE **LAMISOL®** SHIM

FOR QUICK, ASSEMBLY LINE USE

The laminations of the LAMISOL® Shim (in brass) are temporarily joined by spot-soldering on the edges. Gauges and number of laminations within one shim are unlimited.

PACKAGED SHIM STOCK

READY FOR EASY USE, WITHOUT WASTE

Thin gauge 6" x 100" rolls feed through package slots. Heavier gauges in flat envelopes. Available from your Industrial Distributor.

LAMINUM® and LAMISOL® Shims are also made of ALUMINUM; layers are .003".

FLASH! *LAMINUM® now available in STAINLESS STEEL with layers of .002" or .003".*

LAMINATED SHIM COMPANY, INC.

SHIM HEADQUARTERS SINCE 1913

Check Our Stampings Division For Your Stamped Parts Requirements

MAIL TODAY!

LAMINATED SHIM COMPANY, INC.
1201 UNION STREET, GLENBROOK, CONN.

Please send me more information on:

☐ SHIMS ☐ STAMPINGS ☐ BOTH

☐ *We'd like to discuss our problem with one of your Sales Engineers.*

NAME_____ TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE_____ STATE_____

—ITEM 235—

Helpful Literature

factors for 28 other copper-base alloys are also given. 4 pages. Scovill Mfg. Co.

—Circle ITEM 28

Hydraulic Tube Fittings

Dimensional information on new straight thread hydraulic tube fittings with O-ring sealing, both Triple-lok flare and Ferulok flareless types, is provided in catalog 4301. Included are machining dimensions and drawings for internal straight thread boss and listings of counterboring and thread-tapping tools. 20 pages. Parker Appliance Co., Tube & Hose Fittings Div.

—Circle ITEM 29

Alloy Steel Tubing

Mechanical, pressure, airframe and aircraft mechanical are classifications of carbon and alloy steel tubing described in catalog "Ostuco Tubing." Catalog covers both seamless and electric resistance welded tubing, as well as tube fabricating and forging. 8 pages. Copperweld Steel Co., Ohio Seamless Tube Div.

—Circle ITEM 30

Casting Handbook

All factors relating to successful sand, permanent mold or die casting of light-metal parts are discussed in comprehensive pocket-size guide. Of particular interest is 28-page section devoted to characteristics of all conventional aluminum and magnesium casting alloys and all Electron premium magnesium alloys. Advantages and disadvantages of each casting method are covered. 58 pages. Rolle Mfg. Co.

—Circle ITEM 31

Self-Locking Nuts

Flexloc self-locking nuts which can be used either as locknuts or stop nuts are descriptively covered in illustrated folder 866. Fastener is unaffected by up to 550°F temperatures and function well up to 750°F when made of corrosion-resisting steel. Regular and thin-nut heights are available. 4 pages. Standard Pressed Steel Co.

—Circle ITEM 32

Stainless Fastenings

Over 9000 items and sizes are listed in catalog of stainless steel fastenings. Stock and price lists and pertinent data are given for each item. A number of different stainless anal-

(Advertisement)

R B & W Fastener Briefs

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

The Proper Loading of Bolts

The pre-load, or residual tension, in a tightened bolt means more to assembly strength than the actual strength of the bolt itself.

In a joint, a bolt torqued to its proper load level resists a maximum amount of external load without loosening. Designers can take advantage of this fact and assure better results, and at the same time, cut costs.

For example: One designer calculated that truck frames needed high strength bolts at least ½" in diameter. So he used ⅝". But on the assembly line, these were being torqued to 100 ft.-lbs. whereas they needed at least 200 ft.-lbs. for proper residual tension. The ½" bolt at 100 ft.-lbs. would actually have given the stronger assembly and at less cost.

In another case, the bucket on earth moving equipment was always coming loose. The design engineer kept increasing the size of the bolt up to 1¼", but to no avail. The impact wrench used was supplying far too little torque for this size. We suggested a return to the original ¾" bolt used, set up to 350 ft.-lbs. torque. It solved the problem.

In short, the more you stress a bolt within its elastic limit, the greater its ability to stay tight and make a strong assembly.

Symmetrical flow lines assure strong bolt heads

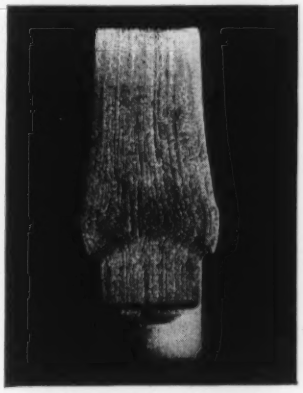


Photo of perfect cold worked blank after first upset.

Effect of improper forming is a poor head like this.

IN THE manufacture of bolts and cap screws, the first upset of metal is a vital one. It determines the flow lines in the bulb which will form the head. A symmetrical flow assures no laps and, therefore, no weak spots or cracks in the final upset of the head.

MACHINE OPERATOR'S SKILL VITAL

The upper photo shows a longitudinal section of a blank after the first upset and on its way to becoming an RB&W standard bolt. Note the even distribution of flow lines. This bulb will become a perfect head.

The lower photo shows what can happen with poor tools, inexperienced operators or without precision setup of the cold headers. Note how pronounced is the unbalanced flow pattern which resulted from a bulb with just a minute defect.

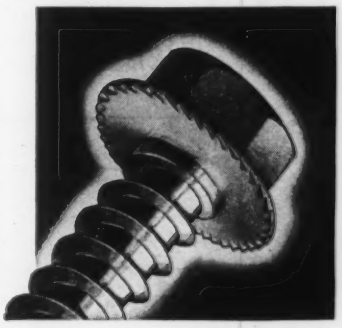
DEPENDABLE FASTENERS

Cap screws and bolts also get a bright smooth finish from the right kind of cold forming. But above all, they offer the designer low cost fasteners with sound internal structure. Standard RB&W fasteners can be loaded to their proper level —become a strong point in any assembly.

For help on your fastener problem, contact Russell, Burdsall & Ward Bolt and Nut Company. Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

The Only Screw That Stays Tight

The continual heating and cooling caused loosening of handle screws on the flat irons of one manufacturer. Every type tried failed to stay tight until RB&W's unique Spin-Lock tapping screws were used. This solved the problem. Their hardened teeth lock into the surface, require more torque to loosen than to tighten. One piece fasteners, they speed assembly time.

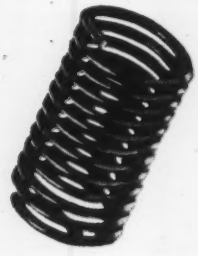


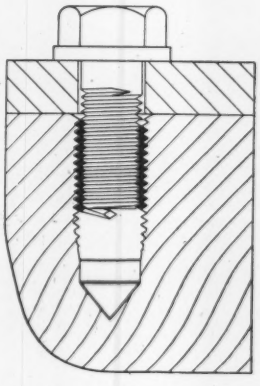
—ITEM 236—

STRONGER CLEANER LIFETIME THREADS

in lighter, softer, thinner materials

with HELI-COIL* Screw Thread Inserts





Heli-Coil Inserts, coils of stainless steel or phosphor bronze wire, produce superior internal threads that solve many design problems. Thousands of manufacturers are using them to greatly increase thread strength in light metals, wood, plastics; to stop corrosion, seizing and galling; and to increase thread life. In thousands of applications ***Heli-Coil*** Inserts now enable designers to use thinner materials, shorter thread engagements, lighter materials—to save space, time and money.

Send in the coupon today. You'll get samples and complete information.

***Heli-Coil* Inserts conform to official Military Standards MS122116-122275(ASG), MS124651-124850(ASG) & MS33537(ASG)**

*Reg. U. S. Pat. Off.

HELI-COIL CORPORATION
121 Shelter Rock Lane, Danbury, Conn.

☐ Send samples and Design Manual 652A.
☐ Send samples and Military Standards Manual 689A.
☐ Please have a *Heli-Coil* Thread Engineer call.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____ 3052

—ITEM 237—

Helpful Literature

yses are available, and quantities on hand are given. Anti-Corrosive Metal Products Co.

—Circle ITEM 33

Needle & Roller Bearings

Design features, dimensions, capacities, and housing and tolerance fits of the complete line of Orange staggered roller, full and cage type needle, journal roller and thrust roller bearings are contained in illustrated engineering reference manual. Data are included on cam followers and cam yoke rollers. 40 pages. Orange Roller Bearing Co.

—Circle ITEM 34

Wire-Wound Resistors

Specifications and features of small wire-wound vitreous-enameled resistors with axial leads in 5 and 10-w sizes are described completely in bulletin No. 147. Carried in stock in wide range of resistance values, resistors are priced. 2 pages. Ohmite Mfg. Co.

—Circle ITEM 35

Hose Couplings

As internal pressure increases, seal becomes tighter in Quick-Seal line of quick connect-disconnect hose couplings described in revised catalog 7-55-20. Couplings will operate at pressures up to 12,000 psi and have full swiveling action that prevents hose twisting and kinking. 20 pages. Titeflex, Inc.

—Circle ITEM 36

AC Power on Wheels

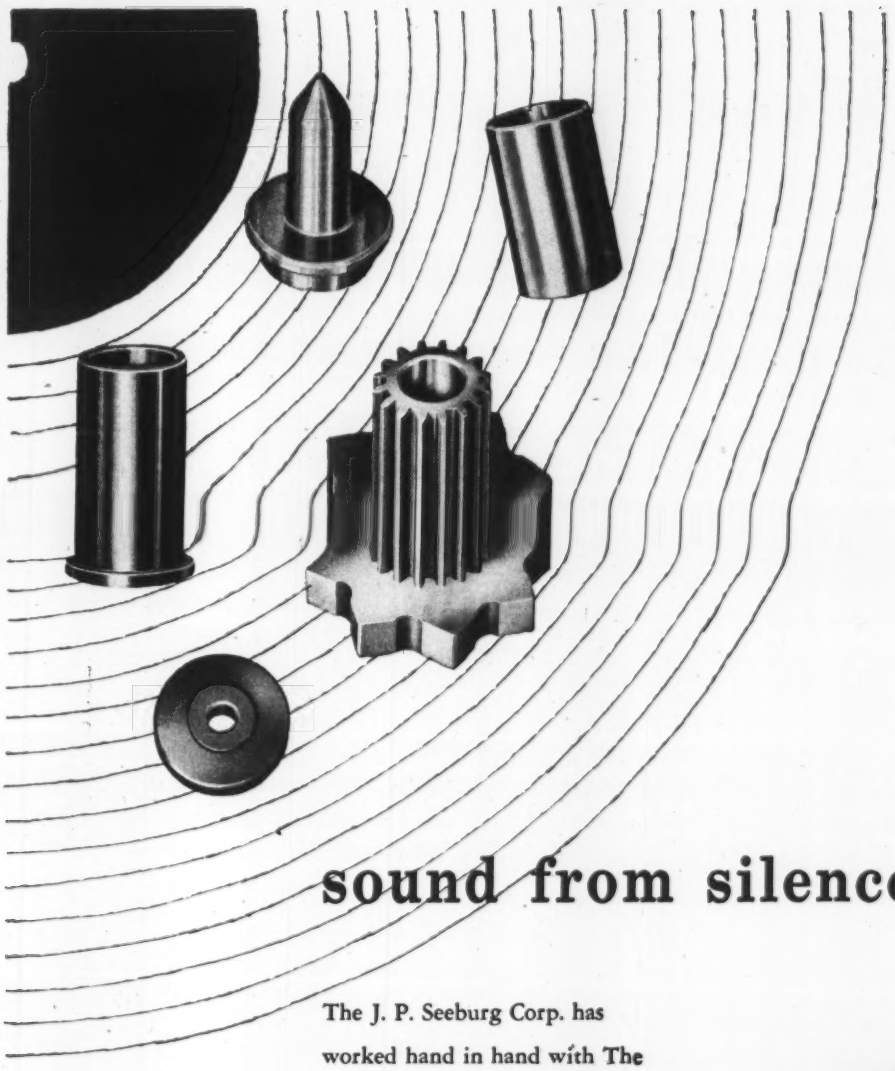
"Now . . . AC Power Goes Anywhere a Vehicle Can Go" is a technical presentation on Mo-Bil-Ac mobile generators which supply up to 10 kw of electricity at standard voltages and frequencies, yet are small enough to mount under the hood of a car or truck. 8 pages. Miehle Printing Press & Mfg. Co., Star-Kimble Motor Div.

—Circle ITEM 37

Air & Hydraulic Equipment

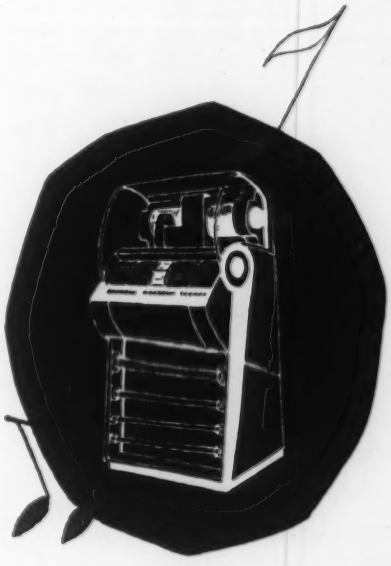
Vacuum and liquid pumps, air brake equipment, and hydraulic motors, controls and pumps are some of the equipment described in illustrated bulletin 1102. This booklet is a guide to the equipment produced by the Aurora Pump, Dudco, Hydreco, Kinney Manufacturing and Watertown divisions. 16 pages. New York Air Brake Co.

—Circle ITEM 38



sound from silence . . . .

The J. P. Seeburg Corp. has worked hand in hand with The United States Graphite Company in developing self lubricating bearings and parts which meet the exacting requirements of the most successful high fidelity coin operated phonograph made today.



GRAMIX®

products from powder metallurgy

112

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

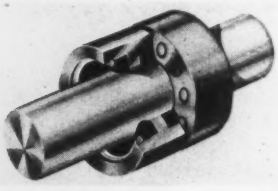
NEW PARTS AND MATERIALS

Use Yellow Card, page 19, to obtain further information

Magnetic Shaft Seals

for large diameters

Made to specifications, model 30 rotary shaft seals are adaptable to both high and low pressures. Employing magnetic inserts, the seals are so designed that the number of cylindrical inserts required to maintain optimal face sealing pressure is determined by the size of



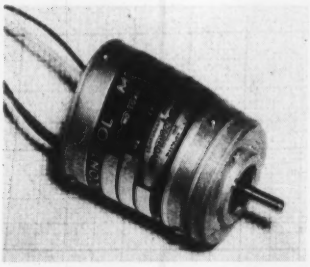
the seal. Balanced pressure eliminates warpage on the face sealing surfaces. Seals can be made in any size. They are compact and require only small axial space. **Magnetic Seal Corp.**, 301 Sowams Rd., Barrington, R. I.

—Circle ITEM 61

Miniature Servo Motor

for high-temperature use

This miniature 400-cycle servo motor withstands continuous Class H operating temperatures. It is designed for a minimum life of 1000 hours of continuous operation at 150 C ambient temperature. The motor measures 1 1/16 in. diam and weighs 3 oz. Applications include use in high-speed equipment operating at high temperatures and where external cooling is not practical. It operates on 115 v per phase. Stall torque is 0.4-oz-in.; no-load speed is 7200 rpm; maximum power output is 0.6-w; and rotor inertia is 1.2 gm-cm^2. **Servomechanisms Inc.**, Components Div., 625 Main St., Westbury, N. Y.

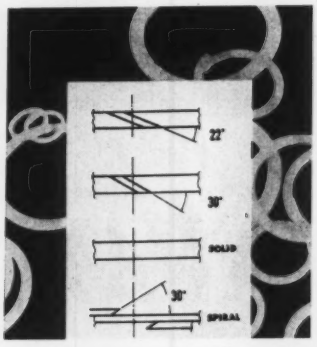


—Circle ITEM 62

O-Ring Backing

available in solid, cut and spiral types

Teflon back-up rings made in solid or spiral form or as rings with 22 or 30-deg cuts are usable in hydraulic and pneumatic applications.



They protect O-ring seals from extrusion. Chemically inert, the packings have very low friction and are unaffected by oils, acids, bases or solvents. They can be used at temperatures ranging from −100 to 500 F. Standard sizes correspond to sizes of both MS and AN O-rings and back-ups. Special sizes and variations are available to meet specific requirements. **Shamban Engineering Co.**, 11617 W. Jefferson Blvd., Culver City, Calif.

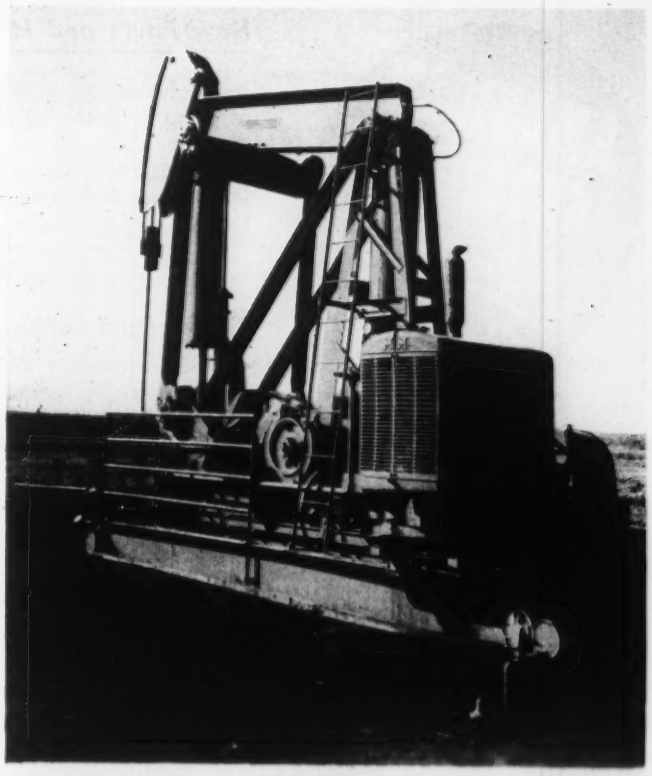
—Circle ITEM 63

Corrosion-Resistant Pumps

in 10, 15 and 20-gpm sizes

Pumps with 10, 15 and 20-gpm capacities and discharge pressure ratings of 0 to 50 psi are available in Flex-I-Liner XB series. Design eliminates the need for stuffing boxes or mechanical seals. Fluid passing through the pump is never in contact with metal, contact being made only with the outer surface of the liner and the inner surface of the pump housing. These two parts are available in various materials which permit the pumps to handle highly corrosive chemicals, abrasive slurries, or fluids which must be kept free from contamination. The pump head is mounted cantilever fashion on a rigid cast iron pedestal. All permanently lubricated bearings are enclosed in stainless steel assemblies, and the rotor and heavy-duty shaft are also furnished in stainless steel. Liner replacement is

Blanketed Base Pans and Automatic Sentries Push Service Dates Apart

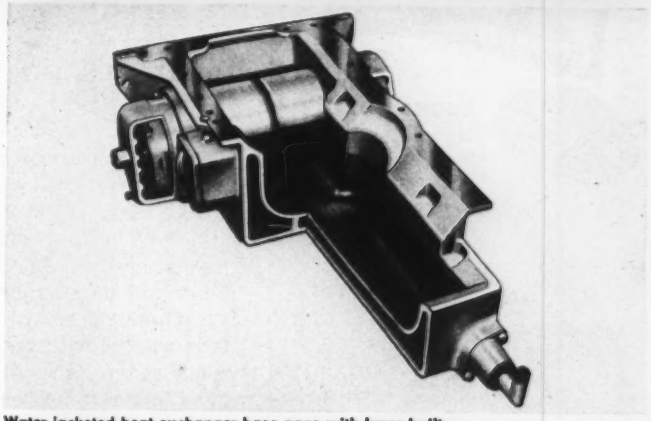


Service dates skip months instead of days where operators have Minneapolis-Moline long-run engines. MM exclusive water-jacketed base pan with large built-in filters keeps engine and lube oil at constant temperature under any load or weather condition.

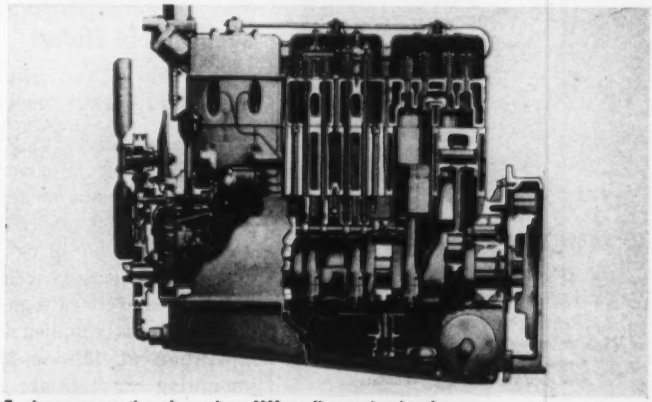
Automatic control of crankcase temperature prevents sludging and enables more effective filtering. The high efficiency of MM exclusive vacuum crankcase ventilation is obtained by blanketing the base pan with engine water. This holds crankcase vapor above the dew point so that (instead of condensing and forming sludge) it is withdrawn.

Added advantages of MM long-run design are extra large permanently lubricated bearings, sealed pressure cooling with water pass and thermostat control, built-in oil-flow controllers and automatic sentries—safety cutouts that prevent damage in case of low oil pressure or excessive water temperature.

Write, wire or call for complete facts and specifications on this lowest-cost, dependable MM power.



Water-jacketed heat exchanger base pans with large built-in filters provide automatic thermostatic control of lube oil temperature. Oil flow controller maintains constant oil level from reservoir supply. Heavy flange on flywheel end provides 360° rigidity to crankshaft alignment.



Engine cross-section shows how MM cooling maintains the entire engine at a constant temperature. Variation maximum is 4° to 5°. Automatic thermostatic control and bypass system act as heater or cooler—engine runs at constant temperature under all operating conditions.

INDUSTRIAL DIVISION

MINNEAPOLIS-MOLINE
MINNEAPOLIS 1, MINNESOTA

—ITEM 239—

XUM

AMERICAN CRUCIBLE knows Bearings!

Send Prints for Quotation

When you are looking for bearings, bushings and wearing parts that will stay on the job and give trouble-free service—SWITCH TO

Promet Engineered Bronze

GET THE GOOD, SOUND QUALITY THAT ASSURES EXCELLENT PERFORMANCE

Discuss your bearing problems with our metallurgists, engineers, and laboratory technicians. This service will in no way obligate you. Write for free literature and service data sheets or send blueprints, conditions of operation and data for recommendations and quotations.

PROMET

THE American Crucible PRODUCTS CO.

"Bearing Specialists Since 1919"

1321 Oberlin Avenue Lorain, Ohio, U.S.A.

Please send free literature and service data sheets on Promet Bronze.

NAME_____

COMPANY_____

STREET_____

CITY & STATE_____

—ITEM 240—

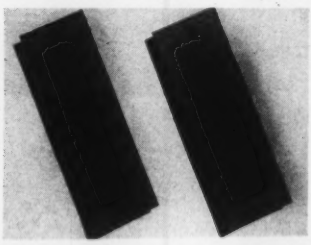
made quickly and without removal of pump mounting, motor connections or pipe lines. **Cooper Alloy Corp.**, Vanton Pump & Equipment Corp. Div., 201 Sweetland Ave., Hillside, N. J.

—Circle ITEM 64

Silicone Paint Additive

produces hammer finish

Silicone additive, designated F-4290, produces hammer effects ranging from coarse to fine when mixed with metallic-base paints. It is effective in concentrations as low as 0.1 to 1 per cent by weight. A solution of silicone polymer in xylene, it is effective in drying type



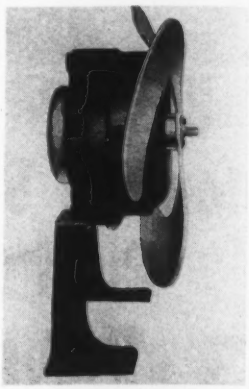
alkyds; epoxies; soya alkyd-melamine; coconut alkyd-melamine; silicones and modified silicones; and acrylic, nitrocellulose or ethyl cellulose lacquers. Shelf life is excellent, and no stirring or mixing is required before use. Panel at left is painted with regular paint; the one at the right with the same paint containing 0.1-per cent additive. **Dow Corning Corp.**, Midland, Mich.

—Circle ITEM 65

Shaded-Pole Motor

available with various mounting arrangements

Shaded-pole, fractional-horsepower model SP-A motor is rated at 1/500 to 1/80-hp at speeds from 1200 to 1550 rpm. It operates at ambient temperatures of 32 to 120 F, and with recommended lubricants it will function at full ratings to −40 F. The motor is supplied for 60-cycle operation at 115 or 230 v. Five mounting brackets are available to make it applicable to compressors, vertical walls, or a variety of equipment requirements. Construction includes a large oil reservoir, a



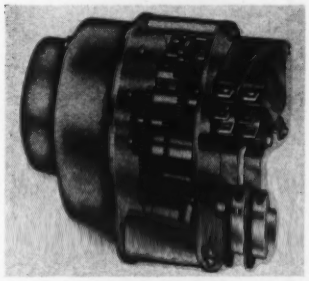
spiral groove viscosity lubrication pump and a die-cast aluminum rotor. A single iron casting supports all major parts. **Morrill Motors**, 3100 Fairfield Ave., Fort Wayne, Ind.

—Circle ITEM 66

Time Delay Relay

instantaneous reset type

Powered by a solenoid-operated differential type movement using a Bristol Circle B motor, time delay relays are available in a wide range. Relay can be made with



various switch combinations and is also available as a clutch type motor. Two-switch unit illustrated is 3 in. long, 2¼ in. in diam and operates on 115 or 220-v, 60-cycle ac. Timers are designed to meet specific requirements. **Vocaline Co. of America Inc.**, Bristol Motor Div., Old Saybrook, Conn.

—Circle ITEM 67

Toggle Switch

four-throw, momentary contact type

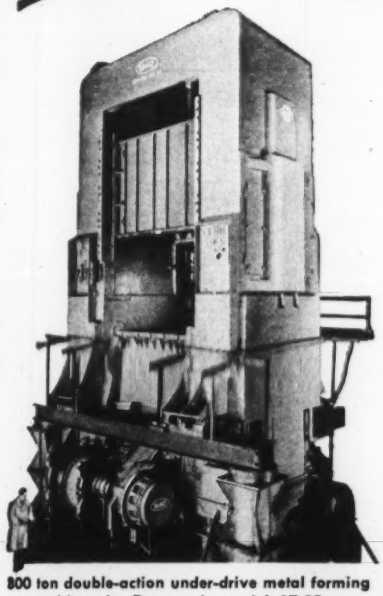
Heavy-duty 5050 series switch is a momentary - contact, single - pole, four-throw, center-off unit with a snap feel. Switch is internally sealed with a silicone boot to keep moisture and dust from the con-

EATON

DYNAMATIC®

EDDY-CURRENT EQUIPMENT

is Solving Speed Control Problems in Every Major Industry

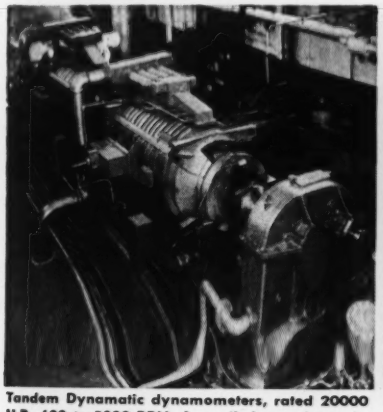


800 ton double-action under-drive metal forming press, driven by Dynamatic model 37-32 combination eddy-current coupling and brake.

In practically all testing, processing, and conveying equipment common to industry, Dynamatic eddy-current rotating equipment is solving a wide range of adjustable speed drive problems, particularly where an AC power source is a requirement.

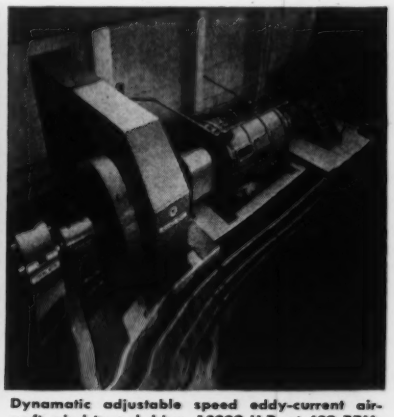
Advantages include rapid response, stepless adjustable speed control, wide speed range, quiet operation, low power loss, low maintenance cost, adjustable speed from an AC power source.

Send for Bulletin GB2, which describes and illustrates the basic Dynamatic eddy-current units, including couplings, brakes, dynamometers, press drives, and Ajusto-Spede® drives.

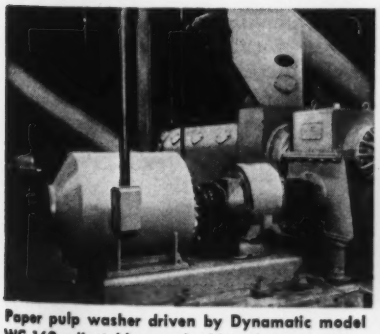


Tandem Dynamatic dynamometers, rated 20000 H.P., 600 to 5800 RPM. A cradled gear box permits turbine testing to 15000 RPM.

Model WC-1308 Dynamatic adjustable speed eddy-current coupling with eddy-current brake, used as printing press drive. Rated 20 H.P at 1700 RPM.

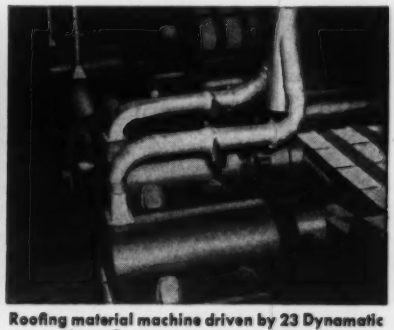


Dynamatic adjustable speed eddy-current aircraft wind tunnel drive, 18000 H.P. at 480 RPM.



Paper pulp washer driven by Dynamatic model WC-160 adjustable speed eddy-current coupling, rated 125 H.P. at 1100 RPM.

Dynamatic model WC-160 adjustable speed eddy-current coupling, rated 100 H.P. at 1100 RPM, used as cement kiln drive.



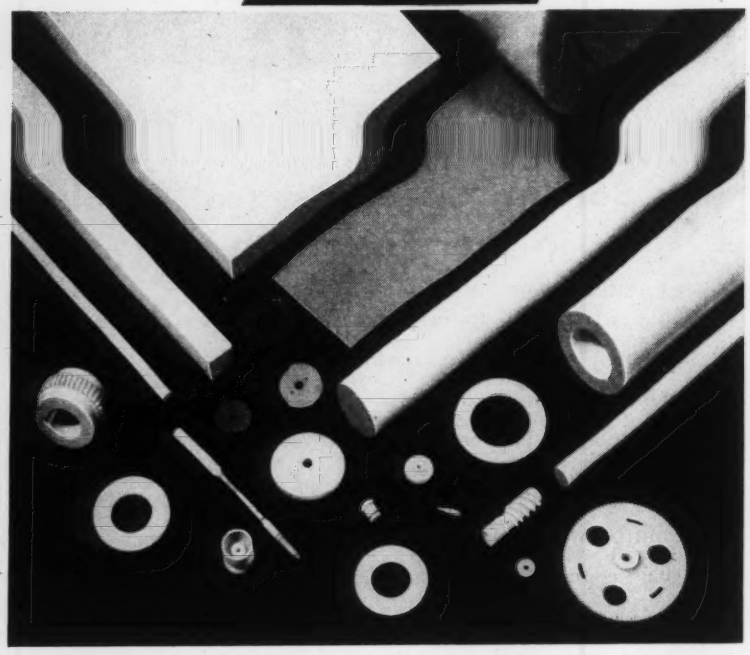
Roofing material machine driven by 23 Dynamatic Ajusto-Spede® drives. All drives and controls completely enclosed and force ventilated.

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

—ITEM 241—

POLYPENCO® NYLON SHAPES



Machine Parts Accurately and at Low Cost from POLYPENCO Shapes

● Simplify your design and production problems right at the start. With high quality POLYPENCO shapes you can fabricate parts at low cost, maintain complete control over production, and change design at a moment's notice.

WHY MACHINING HAS ADVANTAGES

Fabricating from POLYPENCO rod, bar, tubular bar, strip or slab is easily and quickly done on any standard metalworking equipment. Machined parts result in closer tolerances and more uniform dimensions. Moreover, many parts can be produced at high speed on automatic machines.

YOU CONTROL YOUR PRODUCTION

Because nylon parts can be machined from POLYPENCO shapes on conventional metalworking tools in your own shop, direct control over parts production is a simple matter. Production schedules and quality control fall under your direct supervision.

MAINTAIN PRODUCTION SCHEDULES— RAISE UNIFORM QUALITY

You get *all* the desirable properties of nylon in POLYPENCO shapes in piece after piece, order after order. Rigid quality control assures uniform density, dimensional stability, free of porosity and stress spots. This means steadier production and fewer rejects. POLYPENCO Nylon Shapes are stocked in convenient sizes for immediate shipment from warehouses located throughout the country.

For complete data and specifications on POLYPENCO Nylon Shapes write for a copy of the Nylon Bulletin.

THE POLYMER CORPORATION of Penna. • Reading, Penna.
In Canada: Polypenco, Inc., 2052 St. Catherine W., Montreal, P. Q.

POLYPENCO Nylon, Teflon*, Q-200.5 and K-51

*DU PONT TRADEMARK

—ITEM 242—

New Parts

tacts. Contacts operate with fast make and break action and will not weld under current as high as 200 amp. Switch has only one moving part. It operates actuator motors direct, breaks inductive loads at high altitudes and exhibits good vibration and shock characteristics. Construction includes heavy-duty silver alloy contacts and beryllium copper busses. Rating is 20 amp inductive (AN 3179) at 28 v dc for 10,000 cycles and 15 amp inductive at 28 v dc for 50,000 cycles. **Mason Electric Corp.**, 3839 Verdugo Rd., Los Angeles, Calif.

—Circle ITEM 68

Gear Lubricator

spray type panel unit

Spray lubrication of bull gears, girth gears on grinding mills and kilns and other spur or herringbone gear trains can be done by this spray valve panel. Self-contained unit, fastened to gear housings or framework, sprays the lubricant directly to the presure side of the gear teeth. The 2 x 3-ft lubricator has stainless steel spray valves with built-in nozzles. Central pumping units deliver lubricant at regular intervals through

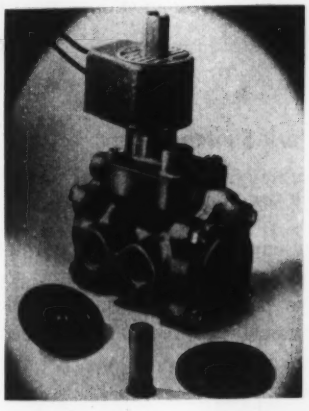
a circuit of Dualine measuring valves which distribute it under pressure to the spray valves, where it is mixed with air. **Farval Corp.**, 3249 E. 80th St., Cleveland 4, O.

—Circle ITEM 69

Three-Way Solenoid Valve

for operation up to 400 cpm

Two Hycar diaphragms and one stainless steel solenoid core comprise the three operating parts of this internal pilot-operated bulletin 8316 three-way solenoid valve. It can be converted from normally closed to normally open operation, or vice versa, by loosening of two bolts and rotating valve bonnet 180 deg. Rated 250 psi on liquids and gases, valve will operate under severe conditions at up to 400 cpm. Full ⅝-in. pressure and exhaust ports provide maximum recycling speed. Unit is available in ⅜ or ½-in. pipe connections and will mount in any position. Solenoid operates from 10.5 w ac or 10 w dc. Manual operator is available, as is either watertight or explosionproof solenoid enclosure. **Automatic Switch Co.**, 391 Lakeside Ave., Orange, N. J.



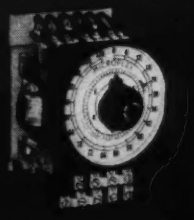
—Circle ITEM 70

Mechanical Seals

for rotary type process pumps

Entire Unitary mechanical seal, including sleeve and gland, is self-contained and ready for quick installation. Several models are available for use on rotary shafts of boiler feed, chemical, oil refinery, digestor circulating and other

EAGLE
Timers and Counters
VITAL COMPONENTS IN MODERN AUTOMATION

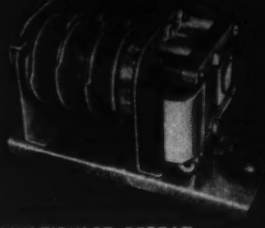


MICROFLEX RESET TIMER

CYCL-FLEX RESET TIMER

MULTIFLEX RESET TIMER

FLEXOPULSE REPEAT CYCLE TIMER



MULTIPULSE REPEAT CYCLE TIMER

MICROFLEX RESET COUNTER

Represented above are but a few of the complete line of popular EAGLE Industrial Timers and Counters.

Models are available in a wide range of modifications to fit your particular application. Modern compact design and precise construction of these EAGLE components has won them an enviable coast-to-coast reputation for accuracy and long service-free life of operation. Write us about your needs.

MAIL COUPON TODAY!

EAGLE SIGNAL CORPORATION
Industrial Division, Dept. MD-156
MOLINE, ILLINOIS

Please send free Automation Booklet "See What Timing Can Do For You."

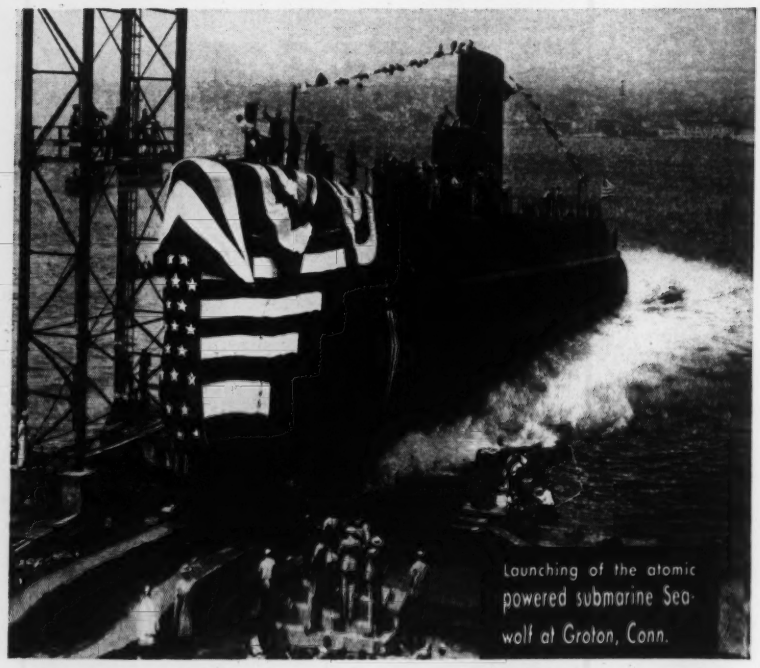
NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

—ITEM 243—



Launching of the atomic powered submarine Seawolf at Groton, Conn.

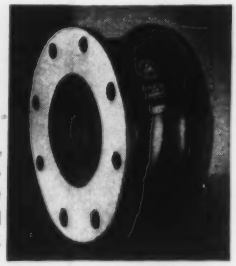
GARLOCK PACKINGS AND EXPANSION JOINTS USED ON U.S.S. SEAWOLF

The Electric Boat Division of General Dynamics Corporation has relied on Garlock packings, gaskets, and rubber expansion joints for *both* of their atomic powered submarines—first on the Nautilus and now on the Seawolf.

You, too, can depend on Garlock products for long, trouble-free service on your applications. Just call your Garlock representative . . . consult with him about your packing requirements.

*Registered Trademark

Left: Garlock CHEVRON* Packing used on the Seawolf for stuffing boxes of hull fittings, including periscope, masts, and antenna.



Right: Garlock expansion joint, neoprene lined and covered. This type was installed on the Seawolf's lubrication and fresh water lines.

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N.Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

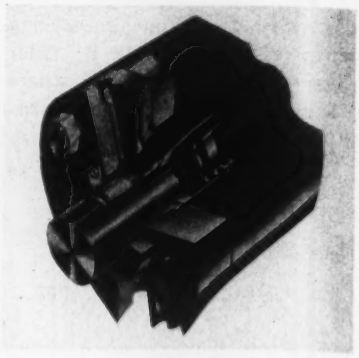
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

PACKINGS, GASKETS, OIL SEALS,

MECHANICAL SEALS, RUBBER EXPANSION JOINTS

New Parts



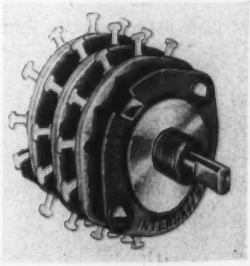
process pumps. They are factory preset and have collet type drive, readily accessible external lock and drive, and circulating connections in glands to provide cool, clean lubrication. Models are available for pressures up to 1000 psi, temperatures to 450 F and shaft speeds to 4000 fpm. Sizes are offered for equipment with shaft or shaft sleeve diameters of 1 to 3 in. and minimum packing space of ½-in. **Garlock Packing Co.**, Palmyra, N. Y.

—Circle ITEM 71

Rotary Switches

subminiature type with up to 12 stator positions per deck

Low-current, subminiature rotary switches can have 12 stator positions per deck exclusive of poles. Standard contact arrangements from 1 pole, 12 positions to 4 poles, 3 positions are offered; all have positive indexing with 1½ lb-in. torque. One, two or three decks can be supplied, with continuous rotation with single-pole or stops for multiple-pole operation. Depth of the switch behind the panel ranges from 0.600-in. for the single-deck type to 1.160 in. for the three-deck model. Construction incorporates a wafer made of an impregnated glass melamine which has high strength and resistance to humidity. Wafer contacts

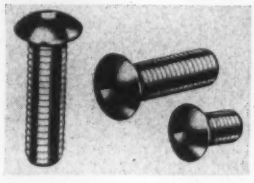


are silver-plated, double-wiping and self-cleaning. Solder type lugs are provided on the wafer's connection ends. Rotor contacts are silver alloy, and are available in either make-before-break or break-before-make types. Contact resistance is 0.015-ohms; dielectric strength, 1000 v rms minimum; insulation resistance, 100 megohms minimum; current-carrying capacity, 1 amp at 50 v dc; and current-breaking capacity, 250 ma at 50 v dc or noninductive ac load. A bushing is provided for mounting. **International Instruments Inc.**, 486 Derby Ave., New Haven, Conn.

—Circle ITEM 72

Socket Screws

have button type heads



Button Head socket screws are suitable for applications requiring a smooth headed fastener for appearance, safety, or tight clearances. They are available in range of sizes from No. 4 wire size to 5/8-in. diameter, with variety of lengths in each size. Screws are made of heat treated alloy steel and have hex sockets. **Bristol Co.**, Socket Screw Div., Waterbury 20, Conn.

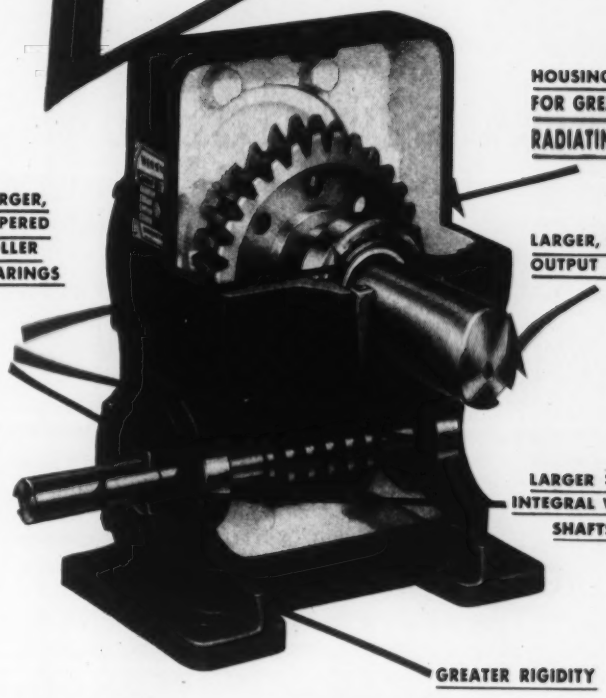
—Circle ITEM 73

Phosphor Bronze

has fine grain size

Presently available in sheet metal up to 0.062-in. thick and wire up to 3/16-in. diam, Duraflex phosphor bronze will be supplied in the various tempers defined by tensile properties in ASTM Specification B 103 for strip and ASTM B 159 for wire. Half-hard, hard, extra-hard, spring and extra-spring tempers will be available, ranging in tensile strength from 55,000 to 109,000 psi. Final anneal of the material produces a grain size of 0.012-mm or less, and the surface of the metal is smooth and free

7 CHECK POINTS of Speed Reducer Design


HOUSING DESIGNED FOR GREATER HEAT RADIATING CAPACITY
LARGER, TAPERED ROLLER BEARINGS
LARGER, STRONGER OUTPUT SHAFTS
LARGER STRONGER, INTEGRAL WORM SHAFTS
GREATER RIGIDITY

...on the New "C" WINSMITH SERIES

THESE 5 IMPROVED FEATURES of Winsmith's new "C" Series reducers mean greater performance, greater stamina, greater dependability...*greater value for your horsepower dollar.*

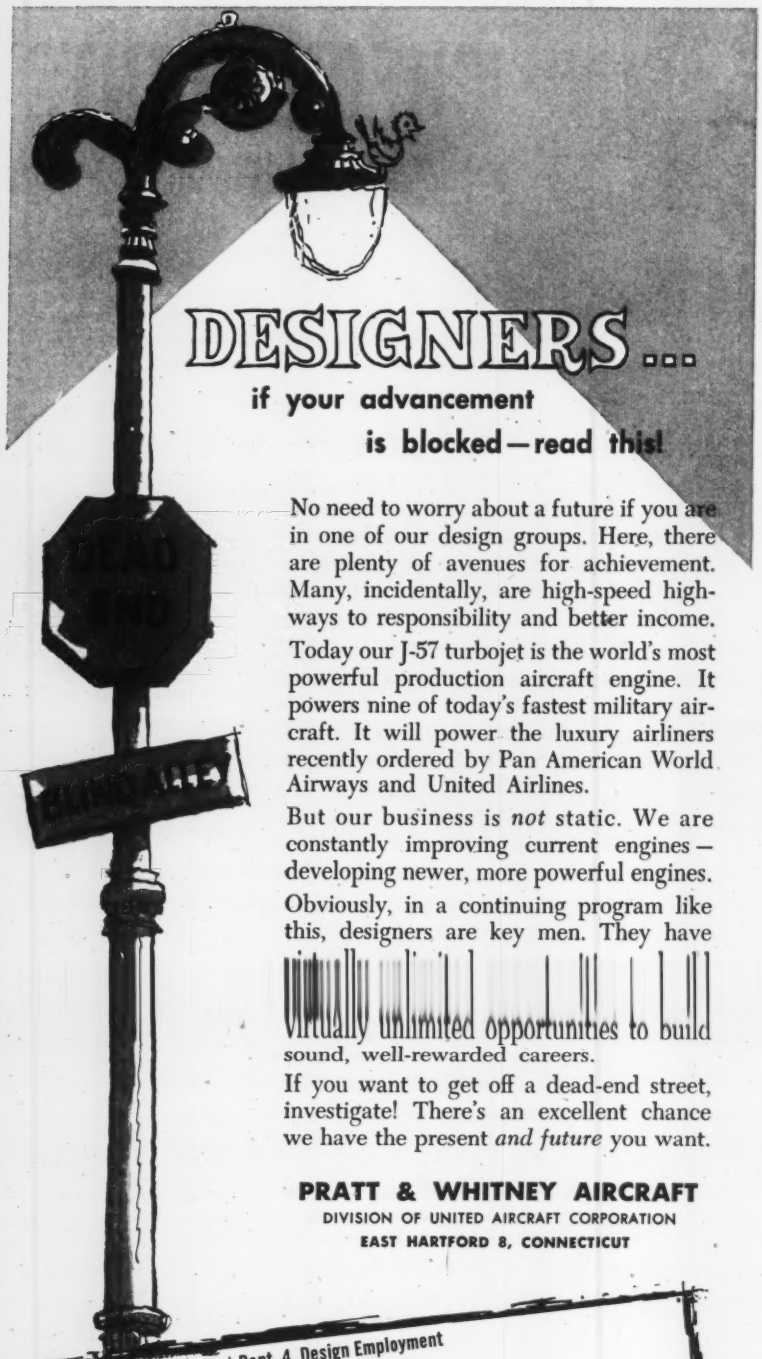
In all, 108 models comprised of single and double reduction units are available in the "C" Series...a unit to answer every speed reducer need. Compare our *increased* rated horsepower and torque output with reducers of competitive makes. For complete data on the "C" Series, write for catalog.

WINSMITH SPEED REDUCERS

NEW CATALOG! Describes the complete "C" Series plus other units in the Winsmith line. Contains drawings, dimensions, weights and ratings for each model described. Write today for Catalog No. 155—on company letterhead, please.

WINSMITH, INC. 16 Elton St., Springville, (Erie County), N. Y.

—ITEM 245—



DESIGNERS ...

if your advancement is blocked—read this!

No need to worry about a future if you are in one of our design groups. Here, there are plenty of avenues for achievement. Many, incidentally, are high-speed highways to responsibility and better income.

Today our J-57 turbojet is the world's most powerful production aircraft engine. It powers nine of today's fastest military aircraft. It will power the luxury airliners recently ordered by Pan American World Airways and United Airlines.

But our business is *not* static. We are constantly improving current engines—developing newer, more powerful engines.

Obviously, in a continuing program like this, designers are key men. They have virtually unlimited opportunities to build sound, well-rewarded careers.

If you want to get off a dead-end street, investigate! There's an excellent chance we have the present *and future* you want.

PRATT & WHITNEY AIRCRAFT
DIVISION OF UNITED AIRCRAFT CORPORATION
EAST HARTFORD 8, CONNECTICUT

MR. E. M. PETERSON | Dept. 4, Design Employment
Pratt & Whitney Aircraft
East Hartford 8, Connecticut

I would like to learn more about your openings for product and component designers. My experience has been in the following fields:

☐ Nuclear Design
☐ Compressors
☐ Turbines
☐ Structures
☐ Afterburners and Related Equipment
☐ Aerodynamics
☐ Hydraulics
☐ Gears
☐ Valves
☐ Heat Exchangers and Combustion Problems
☐ Bearings
☐ Piping
☐ Controls
☐ Test Equipment
☐ Test Rigs
....

Total years Mechanical Design experience .....

You can reach me at ..... (telephone number)

Most convenient hours for receiving calls are between ..... and .....

Name .....

Address ..... State .....

City .....

—ITEM 246—

New Parts

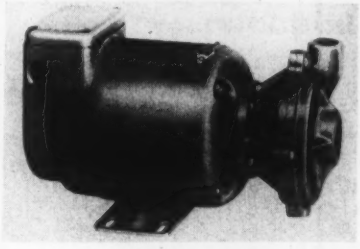
from scratches. Corrosion resistance, fatigue resistance and formability are good. Sheets are available in long coils in weights of 28, 56, 84 or 112 lb per inch of width. **American Brass Co.,** 25 Broadway, New York 4, N. Y.

—Circle ITEM 74

Centrifugal Pump

has self-adjusting seal

Usable in closed, semiclosed or open systems, the model D-500 Rumaco centrifugal pump can be mounted at any convenient point in a horizontal, vertical or angular position without restriction to the



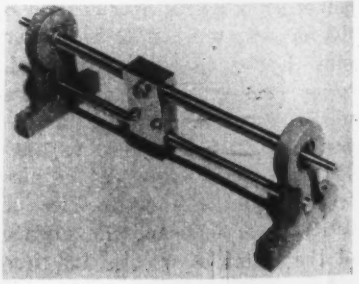
high level line of the liquid in the reservoir. The 1/20-hp unit is equipped with a self-adjusting seal. Discharge position is interchangeable in four 90-deg positions. Pump is available in cast iron or bronze and has a one-piece shaft rotating on two ball bearings. **Ruthman Machinery Co.,** 1811 Reading Rd., Cincinnati 2, O.

—Circle ITEM 75

Lead Screw Assembly

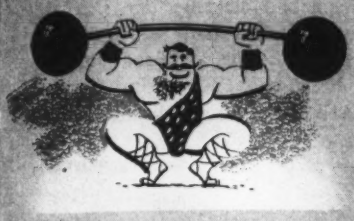
converts rotational motion into linear motion

This precision lead screw assembly converts rotational motion into the linear motion of a carriage traveling along a shaft. The carriage can mount a pen or indicator. Two available assemblies are des-



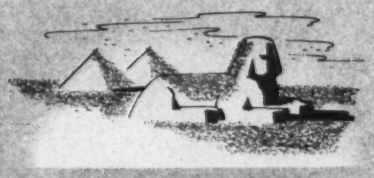
PRODUCT SALEABILITY IS A BASIC REQUIREMENT OF SUCCESSFUL DESIGN

Resistance welding helps you improve your product design



STRENGTH

Resistance welds are stronger than either of the metals welded together. After 10 years of exhaustive tests no other joint survived, practically all automobile manufacturers have adopted resistance welded wheels. The wheels are made with 8 spot welds instead of the 12 conventional rivets . . . using Sciaky equipment.



RESISTANCE TO CORROSION

Resistance welding leaves no exposed metals to corrode, because the weld is within the metals. There are no holes and the joint is tight. However, tight fit-up cannot always be maintained for riveted joints or rivet heads. The result is penetration of atmospheric moisture and corrosion.

LACK OF DISTORTION

Properly applied, resistance welding practically eliminates warpage and distortion. Thus, costly jigs and fixtures to reduce distortion are not necessary on products designed for resistance welding. However, fusion welding produces considerable distortion and does require the extra expense of related fixturing.

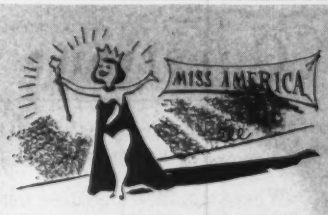
LEAKPROOF

With resistance welding there is no hole

. . . thus it is leakproof. Actually, resistance welding is commonly used to make gastight seams. However, riveted assembly is inherently subject to leakage. Not only costly to make leakproof, it is sometimes even impractical.

REDUCTION OF WEIGHT

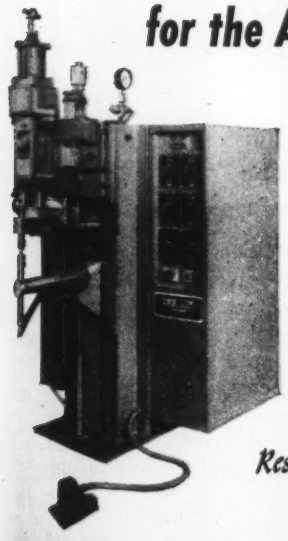
Nothing is added to make a resistance weld—no rod, flux, rivets, etc., are needed. The parent metals themselves are fused together. Resistance welding a product provides a considerable savings in weight compared to riveting, or other forms of welding.



IMPROVED APPEARANCE

Resistance welded spots can be made practically invisible. They need not mar exterior surfaces as do other forms of welding or riveting. Surfaces requiring smooth finish and attractive appearance are best designed for fastening with resistance welding.

Specify Sciaky Patented Three-Phase Resistance Welding for the Advantages of Economy and Consistent Weld Quality



Pioneered, invented, and patented by Sciaky, the three-phase principle of welder operation allows a balanced current to be drawn from all three phases of the power supply.

The result is the lower operating cost of reduced power demand . . . the lower installation costs of smaller switch gear and smaller distribution lines . . . and the consistency of suitable weld quality under high production conditions. For detailed explanation of these and other impressive advantages of Sciaky patented Three-Phase operation, write for Bulletin 332.

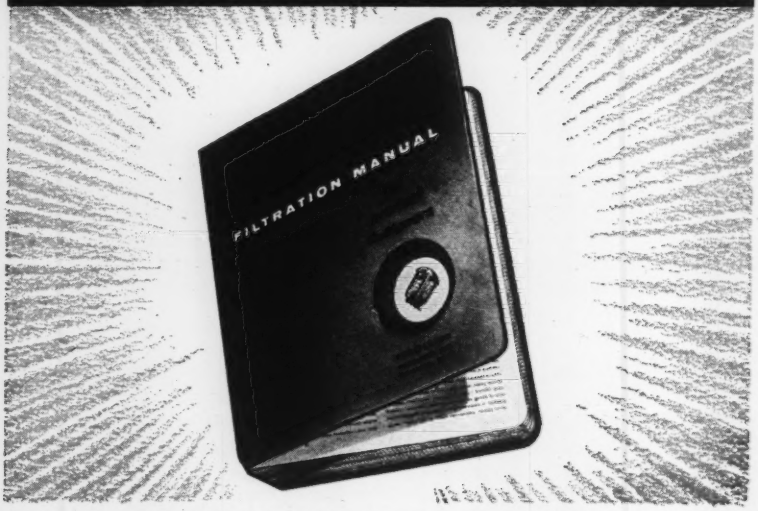
. *Detailed examples* of Sciaky resistance welding applications are available in regular issues of "Resistance Welding at Work." Read how other companies large and small have improved their product and lowered fabricating costs. Send your name and title on company letterhead for these impressive examples of Sciaky's basic thinking—welders designed to do *more useful work* at *lower operating costs* with *maximum reliability.*

Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY®

Sciaky Bros., Inc., 4939 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

FILTER FORUM



New publication by Purolator is the first comprehensive filtration guide ever edited specifically for designers

Question:

Where can a designer find all the answers to his filter problems?

Where can filters be used profitably? When should they be used? How do filters save money? What are the facts about degree of filtration, flow rate, contamination to be removed, viscosity of fluid? These are questions that continually come up in design work. But, up to now, no handy, authoritative source has been available for the designer's files.

Answer:

Purolator's new "Filtration Manual for Product Designers"

Now, for the first time, Purolator's new manual gathers all the answers in one place and makes them available to the product designer. "Filtration Manual for Product Designers" spells out application considerations in detail and includes a complete glossary of terms that apply to filtration. Here are some typical section headings:

	PAGE
WHY ARE FILTERS USED	4
WHERE FILTERS ARE USED	6
PLANNING FILTRATION IN ADVANCE	8
FILTRATION ENGINEERING	10
How filters are applied	10
Glossary of filtration terms	16
How Purolator filters are made	18
WHERE THE DESIGNER CAN SELECT A FILTER	22
Gasoline engine lubrication	23
Tank and crankcase breathers	23
Air intake for engines and compressors	23
Hydraulic fluid	24
Machine tool coolant	25
Bulk fuel handling	26
Diesel engine fuel	28
Diesel engine lubrication	28
Fuel oil burner	29
APPLICATIONS THAT CALL FOR SPECIALIZED STUDY	30

PUROLATOR

FIRST in the field of filtering

MAIL THIS COUPON FOR YOUR COPY

Dept. D7-18, Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.

Please send me the following:

_____ Copy of "Filtration Manual for Product Designers". I'm including 25¢ to cover postage and handling.

_____ Enclosed is a description of our filter problem. How should we solve it?

NAME_____ TITLE_____

COMPANY_____ ADDRESS_____

CITY_____ ZONE_____ STATE_____

—ITEM 248—

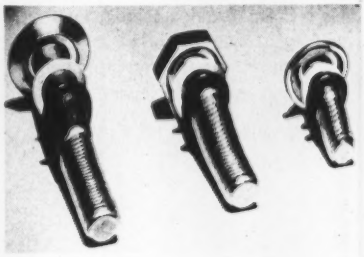
ignated X1-1, which has 0.0500-in. of movement per revolution, and X1-2, which has 0.0356-in. of movement per revolution. Other leads are available. Units have Barden precision ball bearings of ABEC-7 quality and are made of stainless steel, except for anodized aluminum hangers. **PIC Design Corp.**, 160 Atlantic Ave., Lynbrook, L. I., N. Y.

—Circle ITEM 76

Self-Sealing Fasteners

seal to mating surfaces

Heads of these threaded fasteners seal to the mating surface. The fasteners have high shear and tensile strength. Sealing is accomplished by the use of standard AN or MS O-rings located in the O-ring grooves, cold-headed into the fasteners. A thin Teflon washer between the O-ring and the head of the fastener prevents friction and allows the rubber to flow evenly in all directions. Bolts are made in lengths and grips specified by AN and NAS standards. Heads are slightly oversize to incorporate the



O-ring groove. The fasteners are available in various head styles, including a 100-deg countersunk type. **Aero Bolt & Screw Co. Inc.**, 1071 W. Arbor Vitae St., Inglewood, Calif.

—Circle ITEM 77

Foot Switches

offer three types of contact

Clipper precision snap-action foot switches are available with three types of contact. The momentary contact model is started by pressing and stopped by releasing; the maintained contact model is both started and stopped by pressure; and the impulse contact model operates by pressing and releasing,

A WICHITA Low-Inertia *AIR-TUBE* Clutch is

EVERYTHING YOU WANT IN A CLUTCH!

LONGER LIFE

SAFER OPERATION

EFFICIENCY ENGINEERED

CENTRIFUGAL FORCE DOESN'T AFFECT CAPACITY

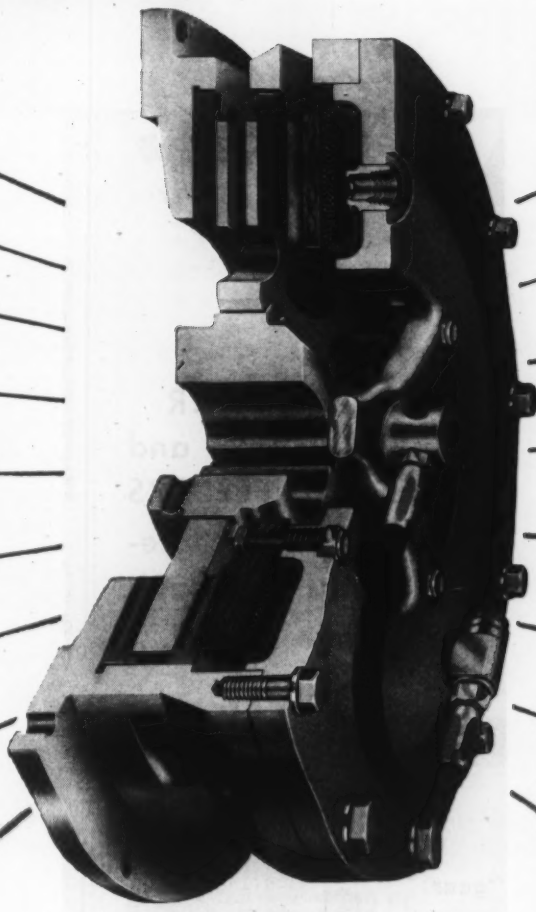
PROVEN ON THOUSANDS OF JOBS

NO LUBRICATION

MINIMUM SLIPPAGE

FASTER ENGAGEMENT AND DISENGAGEMENT

SIMPLE DESIGN



LESS DOWNTIME

NO BACKLASH

LESS MAINTENANCE

6" DIAMETER TO 48" DIAMETER, SINGLE AND DOUBLE-PLATE TYPES

INCREASED PRODUCTION

POSITIVELY VENTILATED FOR COOLER OPERATION

VERY LOW MOMENT OF INERTIA

NO ADJUSTMENTS

The remarkable record being made by WICHITA Clutches proves their unchallenged superiority. Thousands are in use and, because of their durability, mechanical perfection and sound engineering principles, none has ever had to be replaced or removed!

All of the best features of the disc-type clutch have been combined with WICHITA's own features . . .

the advantages of direct air engagement plus the simplest and most trouble-proof application of air pressure today . . . direct axial pressure through compressed air in a rubber tube.

Consult Your Nearest Wichita Engineer for Complete Detailed Information

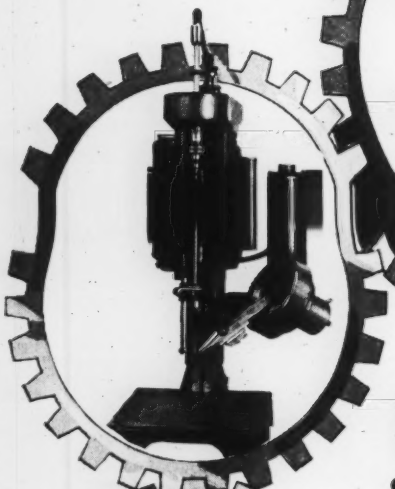
WICHITA DISTRIBUTORS

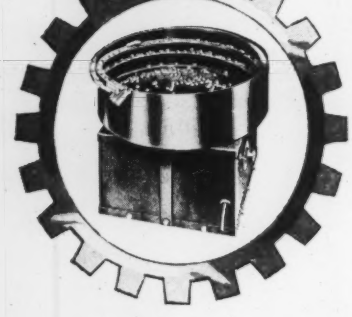
Brehm-Lahner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., (Main Office) Avon, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, N. Y.
Frank W. Yarline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.
Robert R. King Co., Cleveland, Ohio
John C. Burge, Oklahoma City, Oklahoma
Dominion Power Press Equipment Ltd., Longacres P. O., Aldershot, Ontario, Canada
Hunt Tool Co., Houston, Texas
Industrial Air Controls Co., Ft. Worth, Texas
Allied Transmission Equipment Co., Kansas City 8, Missouri
Sales Engineering Co., Inc., Salt Lake City 4, Utah

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

Are You Geared to Meet Today's PRODUCTION DEMANDS?

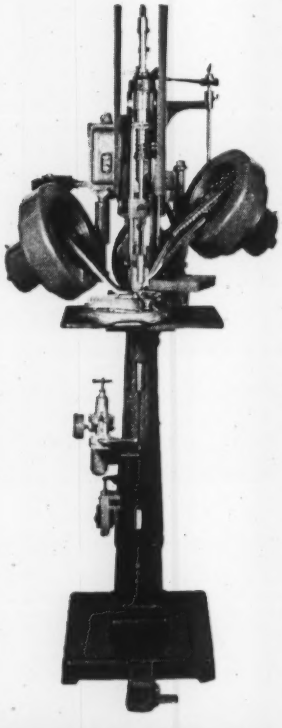
MAXIMUM OUTPUT — MINIMUM costs





DPS POWER SCREWDRIVERS and SELECTIVE FEEDERS *enable you to meet requirements in today's competitive market.*

● Line up this modern "gear train" for added profits. The DPS Power Equipment line is complete and flexible . . . Adaptable to the majority of production bottlenecks . . . It could be the answer to your problem . . . Tell us your story . . . Send for detailed catalog . . . Write today.



DETROIT POWER SCREWDRIVER CO.

2801-A W. FORT ST. DETROIT 16, MICHIGAN

—ITEM 250—

New Parts

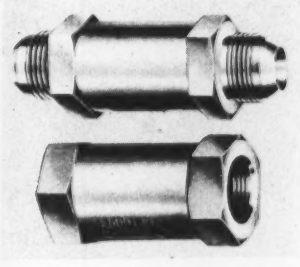
with a fraction of a second contact. All of the switches can be operated easily from either a sitting or standing position. They are available with single-pole, double-throw and double-pole, double-throw circuits. Cast iron housings provide good protection from dust while permitting access to the wiring. **Linemaster Switch Corp.**, 432 Woodstock Terrace, Woodstock, Conn.

—Circle ITEM 78

Lightweight Check Valves

for 3000-psi service

AN-approved ½-in. aluminum alloy check valves for 3000-psi hydraulic service are said to be 55 per cent lighter in weight than conventional type check valves. Two models are available, with



either external or internal threaded ends. The valves have an ambient temperature range of −65 to 160 F. They assure unidirectional flow and will withstand over 50,000 cycles. Valves can be supplied with seals for up to 275 F service. **Aircraft Products Co.**, 300 Church Rd., Bridgeport, Pa.

—Circle ITEM 79

Solderless Connectors

available in six sizes

Quick connections of wiring without soldering is possible with 2700 series tapered terminal and receptacle lugs. Any type of circuit con-

nection can be made, and the lugs can be used for etched circuit and multiple stacking applications. Six standard sizes range from 0.328-in. above board and 0.113-in. diam to 0.421-in. above board and 0.118-in. diam. Single-end or double-end terminals and feed-through types are available. They fit standard terminal board thicknesses from 1/32 through 3/16-in. Designed for use in conjunction with Amphenol or similar pins, the lugs are made of half-hard brass and are either unplated or silver-plated. Any required finish can be provided.

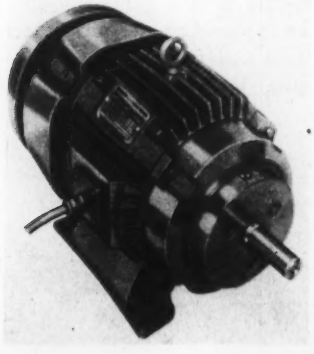
Current-carrying capacity is excellent. Pull-out force required at room temperature is approximately 21.3 lb. **U. S. Engineering Co. Inc.,** 521 Commercial St., Glendale 3, Calif.

—Circle ITEM 80

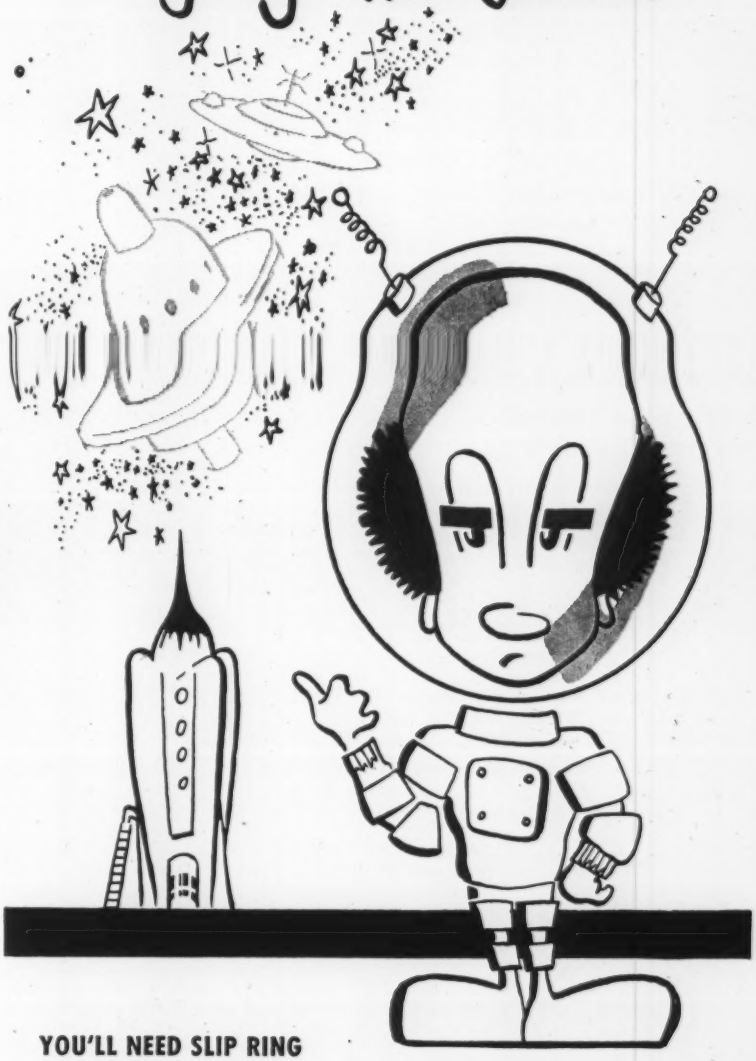
Totally Enclosed Motors

in ratings of 1 to 20 hp

Designed for use in textile machinery, these lintproof ac motors are also suitable for applications in such fields as woodworking, rock and cement, paper, plastics and rubber. Totally enclosed, nonventilated motors are available in ratings to 2 hp; totally enclosed, air-cooled models range in capacity from 3 through 20 hp. Motors are built to new NEMA dimen-



Designing A New Satellite?



YOU'LL NEED SLIP RING ASSEMBLIES . . . AND NO ONE CAN MAKE THEM BETTER THAN PMI

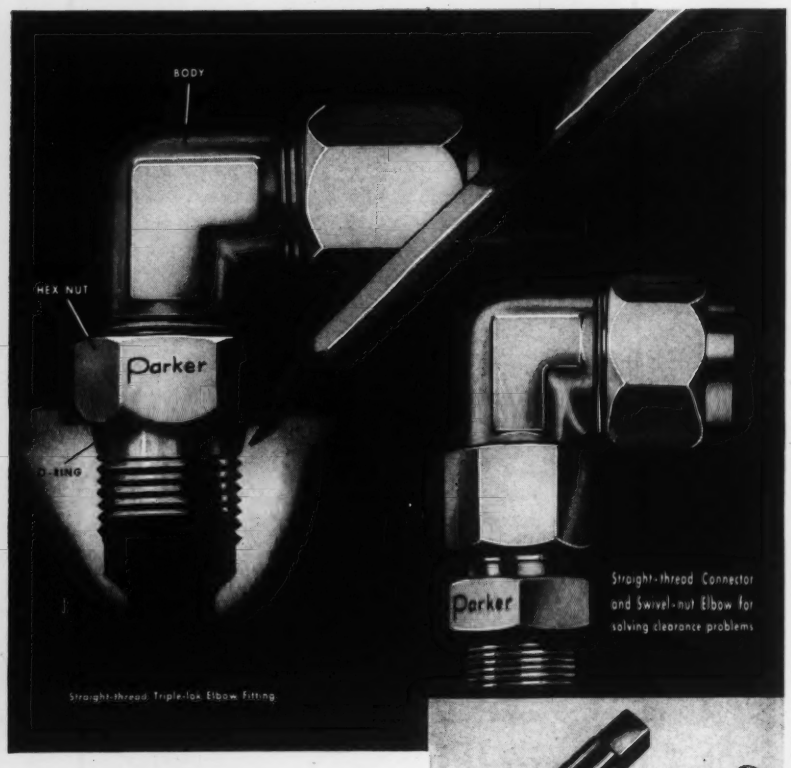
Before your new design leaves the drawing board, whether it be for a synchro or a satellite, if the plans call for a slip ring (collector ring) assembly, let us give you the benefit of our 13 years experience. From one circuit miniatures to 500-circuit giant installations, we can design, develop and produce the assembly to do the job.

PMI Engineers work out all production and design details. Give us a call for free estimate.

PMI

P M INDUSTRIES, INC.
264 FAIRFIELD AVENUE
STAMFORD, CONNECTICUT

—ITEM 251—



Precision thread-tapping and counterboring tools for making accurate *straight*-thread boss (to receive these new Parker *straight*-thread fittings) are now available with machining drawings from Parker.

New Parker *straight*-thread fittings solve your leakage problems

Now you can forget about high-pressure hydraulic problems resulting from tapered pipe threads. Forget about leakage . . . about the danger of cracking or distorting valve bodies by over-tightening the fittings . . . about damaged threads from over-tightening to obtain proper positioning. Forget about messy pipe "dope".

You can eliminate all of these problems by using new Parker *straight*-thread fittings with positive O-ring seals. (See illustration above.)

Parker *straight*-thread fittings are now being supplied in response to the growing demand for this new type of leakproof, trouble-free connection. They are shorter and have smaller hexes than the AN fitting for the old AND 10050 boss. *Straight* threads are available on *Triple-lok* (the industrial standard flare tube fitting) and on *Ferulok* (flareless fitting for heavy steel tubing).

This is another example of Parker's pioneering leadership in the field of hydraulic fittings. Write for Cat. 4301.

TUBE AND HOSE FITTING DIVISION
Section 414-K
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid system components

—ITEM 252—

New Parts

sions. Design of motors includes smooth contouring and finish which provide good lint-passing ability. Cleaning is not required. **Reliance Electric & Engineering Co.**, 1088 Ivanhoe Rd., Cleveland 10, O.

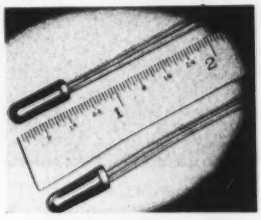
—Circle ITEM 81

Junction Transistors

deliver 200 mw on

6-v battery supply

Matched-pair type 2-OC72 p-n-p transistors are suited to applications requiring up to 200 mw output. They deliver this power on a 6-v battery supply. Design incorporates a highly efficient emitter.



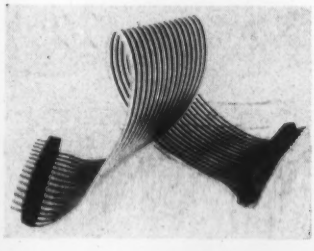
These push-pull units exhibit high current gain at low supply voltages as well as high power output. **Amperex Electronic Corp.**, 230 Duffy Ave., Hicksville, L. I., N. Y.

—Circle ITEM 82

Flexible Wiring Harness

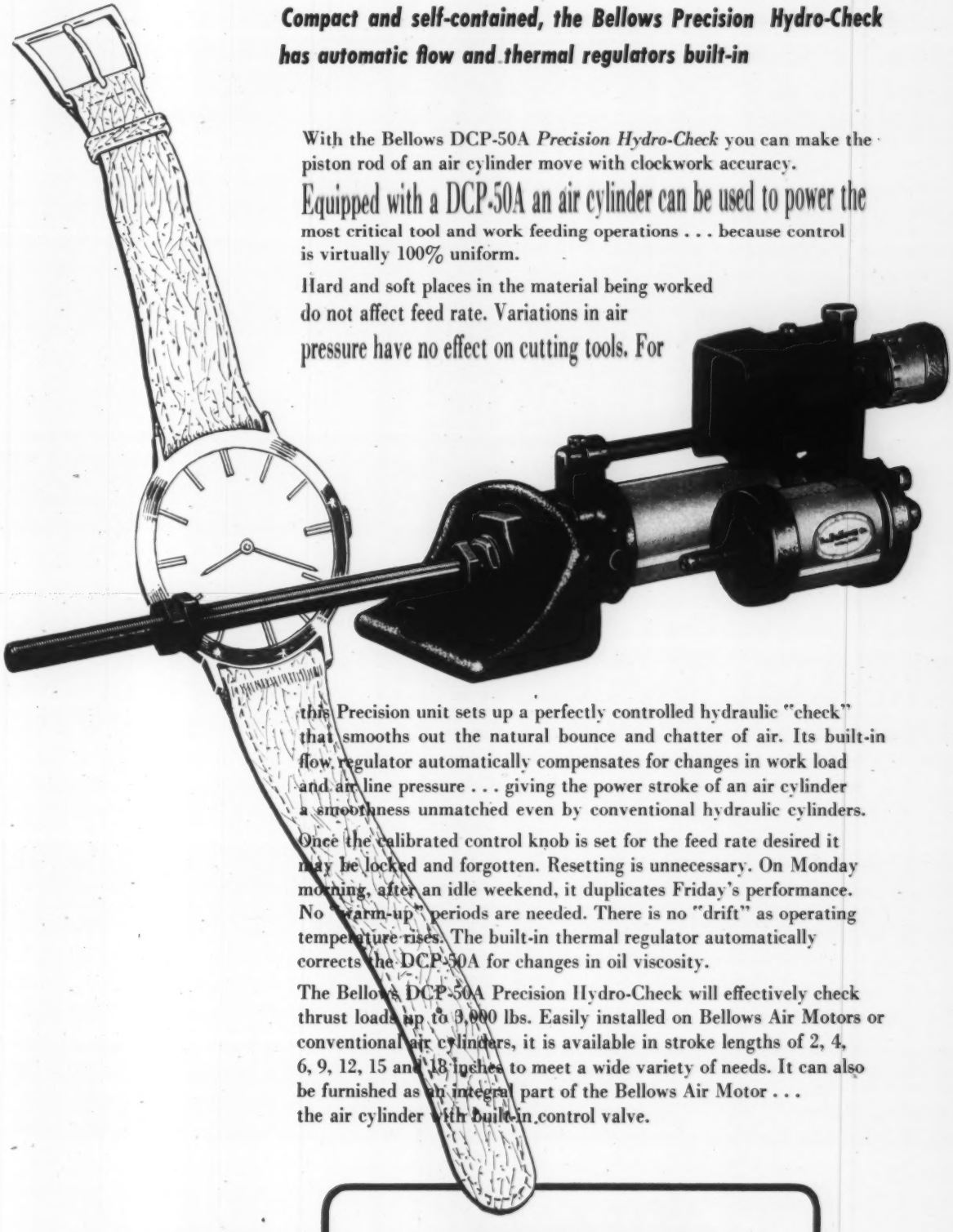
composed of copper laminated with plastic

Copper laminated with Kel-F in thin sheets produces this multiple-conductor cable, or wiring harness. Encapsulation of the conductors in the plastic provides protection against moisture and permits operation over a wide range of environmental conditions. Glass cloth can be included in the laminations for increased strength and high temperature stability. Lightweight and thin, the cables are adaptable to many types of connectors or terminations and are easily secured by clamps, rivets or cement. Addi-



This hydraulic unit controls air cylinder movement with *21-Jewel Precision*

Compact and self-contained, the Bellows Precision Hydro-Check has automatic flow and thermal regulators built-in



With the Bellows DCP-50A *Precision Hydro-Check* you can make the piston rod of an air cylinder move with clockwork accuracy.

Equipped with a DCP-50A an air cylinder can be used to power the most critical tool and work feeding operations . . . because control is virtually 100% uniform.

Hard and soft places in the material being worked do not affect feed rate. Variations in air pressure have no effect on cutting tools. For this Precision unit sets up a perfectly controlled hydraulic "check" that smooths out the natural bounce and chatter of air. Its built-in flow regulator automatically compensates for changes in work load and air line pressure . . . giving the power stroke of an air cylinder a smoothness unmatched even by conventional hydraulic cylinders.

Once the calibrated control knob is set for the feed rate desired it may be locked and forgotten. Resetting is unnecessary. On Monday morning, after an idle weekend, it duplicates Friday's performance. No "warm-up" periods are needed. There is no "drift" as operating temperature rises. The built-in thermal regulator automatically corrects the DCP-50A for changes in oil viscosity.

The Bellows DCP-50A Precision Hydro-Check will effectively check thrust loads up to 3,000 lbs. Easily installed on Bellows Air Motors or conventional air cylinders, it is available in stroke lengths of 2, 4, 6, 9, 12, 15 and 18 inches to meet a wide variety of needs. It can also be furnished as an integral part of the Bellows Air Motor . . . the air cylinder with built-in control valve.

FOR COMPLETE INFORMATION ON BELLOWS HYDRO-CHECKS WRITE DEPT. MD-156

The Bellows Co.
AKRON 9, OHIO

1327A

—ITEM 253—

3 reasons why CARBON is a top performer in industry

For 50 years, carbon engineered products by Morganite have played important roles in many industries and in diversified applications. Here are just three outstanding examples:

- **In the textile and chemical industries, self-lubricating carbon-graphite bearings eliminated the danger of oil and grease lubricants.**
- ***In industrial and electrical generating plants,* heat-resisting carbon bearings solved problems where high temperature prohibited the use of conventional lubricants.**
- ***In food processing plants,* inert carbon pump vanes and seals solved the problem of product contamination.**

Morganite's Engineering Staff is always ready to help with your design or maintenance problems. Write today for Morganite's brochure on Carbon Specialty Products.

TRADE MARK Morganite INCORPORATED

Manufacturers of fine carbon-graphite products for 50 years
3302-3320 48TH AVENUE, LONG ISLAND CITY 1, NEW YORK

—ITEM 254—

New Parts

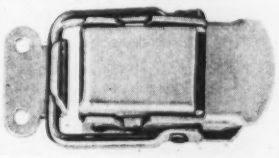
tional conducting and insulating layers can be added to the basic cable to increase the number of separate conductors. **Sanders Associates Inc.**, Nashua, N. H.

—Circle ITEM 83

Spring Catch

holds with 70-lb compression

This spring catch provides a watertight seal when used with a rubber gasket and has 70-lb compression in the closed position. Suit-



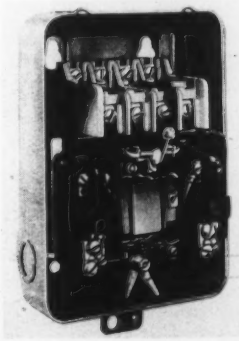
able for use on machine bases and shields, instrument boxes exposed to elements, and electrical control banks and panels, it meets various government specifications. **J. H. Sessions & Son**, Bristol, Conn.

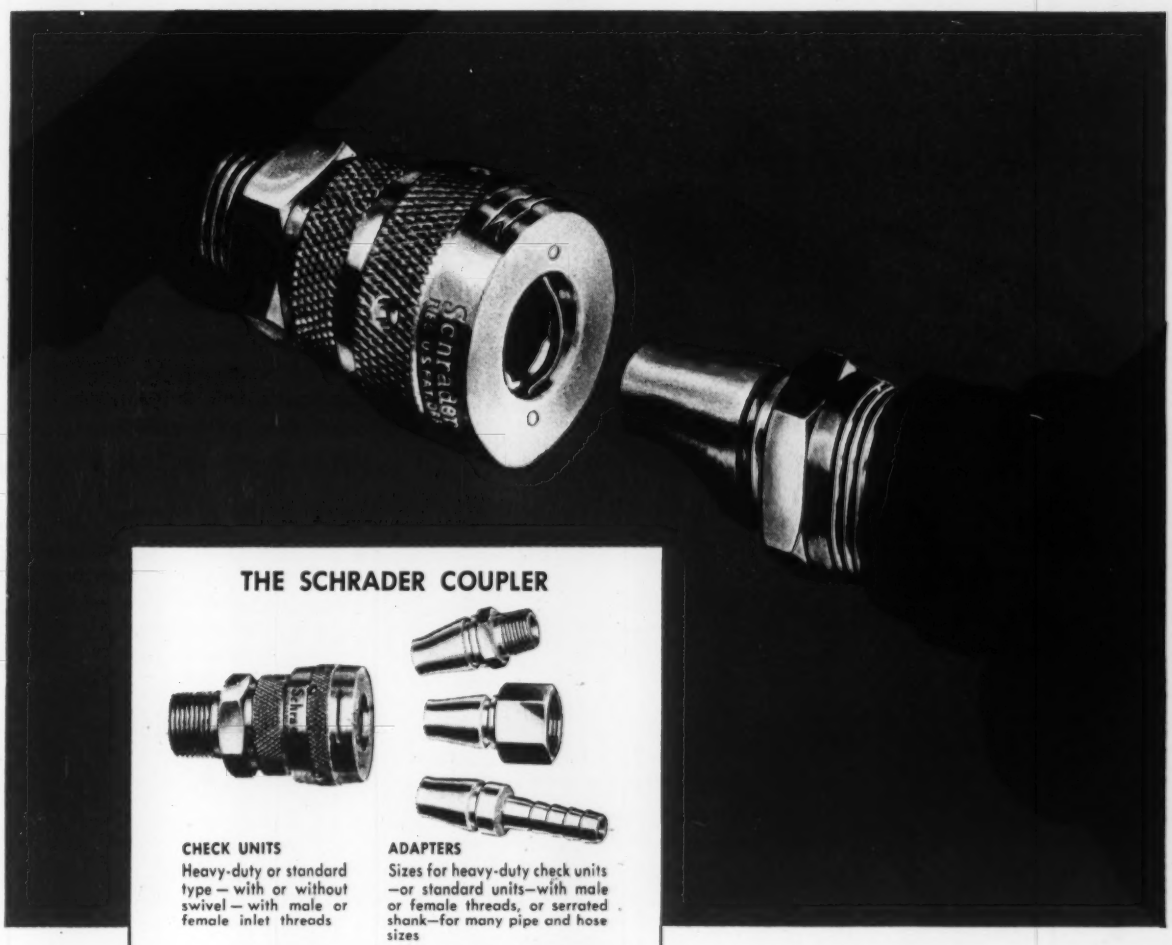
—Circle ITEM 84

Motor Starter

has coil suitable for low or high voltage

Motor controls equipped with Dual Seal dual voltage coils are resistant to combustion, moisture, fungus, temperature changes and shock. Coils have tensile strength of 10,900 psi and compression strength of 17,000 psi. Protected by modified epoxy resin, the coil withstands temperatures of −90 to 250 F. Designed specifically for use with dual voltage motors, these starters are said to virtually eliminate coil changing and starter stocking. A single coil serves on




THE SCHRADER COUPLER
CHECK UNITS
Heavy-duty or standard type — with or without swivel — with male or female inlet threads
ADAPTERS
Sizes for heavy-duty check units —or standard units—with male or female threads, or serrated shank—for many pipe and hose sizes

Plug in for air power nearest the job

Spot Schrader Couplers everywhere in your plant—along benches . . . on columns . . . wherever an air outlet means convenience. Schrader Quick-Acting Couplers make air as easy to "plug in" as electric current. Yes, bring air to the job, not the job to the air line—and you'll get greater portability in your air tools . . . eliminate extra lengths of hose and miles of foot steps.

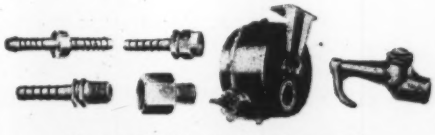
Schrader Couplers are quick . . . they're safe . . . they're sure.

To connect, just push the adapter section into the check unit. Accidental uncoupling is impossible—it takes a positive manual twist of the check unit sleeve to disconnect the coupler and shut off the air.

Make compressed air accessible in your plant, as the largest and most modern plants have done. Schrader Couplers are available in many pipe thread sizes and hose adapters. And remember—Schrader produces a full line of cylinders, valves and other air control equipment, to make your compressed air circuits neat . . . efficient . . . reliable. For details, write today—or fill out the coupon below.

Schrader
REG. U. S. PAT. OFF.

LEADERS IN AIR CONTROL SINCE 1844



The complete Schrader line of pneumatic accessories includes everything you need

A. Schrader's Son
Division of Scovill Manufacturing Company, Incorporated
476 Vanderbilt Avenue, Brooklyn 38, N. Y., Dept. H-13

I am interested in more information on_____

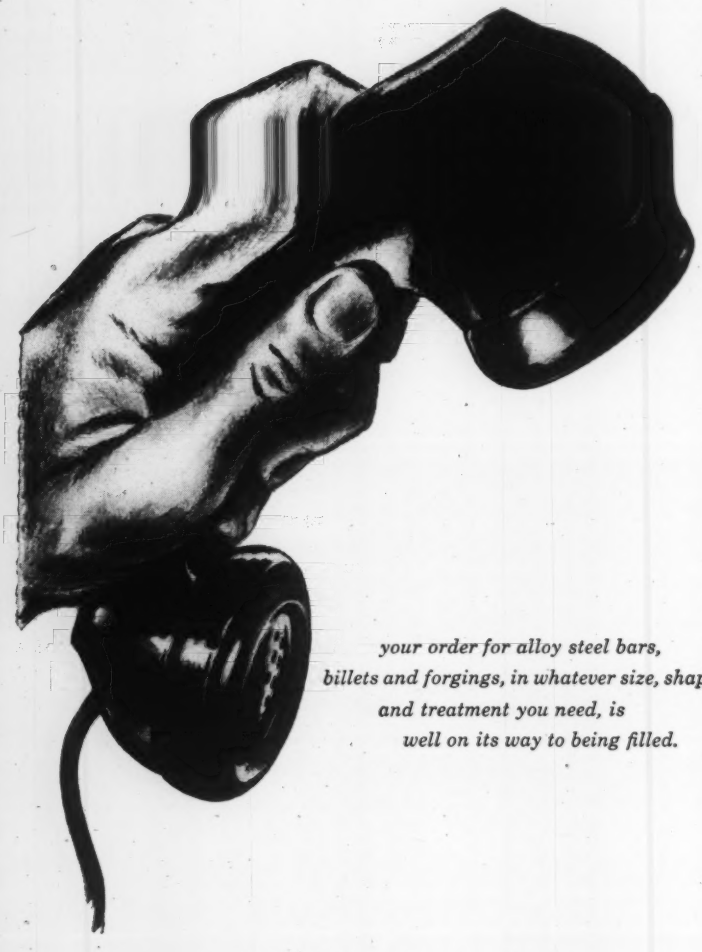
Name_____ Title_____

Company_____

Address_____

—ITEM 255—

Before you hang up,



your order for alloy steel bars, billets and forgings, in whatever size, shape and treatment you need, is well on its way to being filled.

All seven of our modern warehouses are located in principal industrial areas... near you. Each one is well-stocked: equipped to fill your alloy steel requirements promptly, whether you need standard AISI, SAE or our own special HY-TEN steels—"the standard steels of tomorrow". Every warehouse, too, is staffed with experts in metallurgy who are ready to serve you.

Write today for your FREE copies of Wheelock, Lovejoy Data Sheets. They contain complete technical information on grades, applications, physical properties, tests, heat treating, etc.

near you . . .

Warehouse Service – Cambridge • Cleveland • Chicago Hillside, N. J. • Detroit • Buffalo • Cincinnati

In Canada–Sanderson-Newbould, Ltd., Montreal and Toronto

WHEELOCK, LOVEJOY & COMPANY, INC.

133 Sidney Street, Cambridge 39, Massachusetts

—ITEM 256—

New Parts

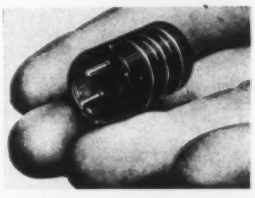
3, 7½ and 10 hp starters for 220/440v where six would ordinarily be required. **Furnas Electric Co.**, 1045 McKee St., Batavia, Ill.

—Circle ITEM 85

Plug-In Capacitors

for printed wiring boards

Enclosed in premolded cylindrical shell of nonflammable thermosetting plastic, type 89P Autocon one-ended case solid dielectric paper capacitors are designed to meet requirements of printed wiring board assemblies. Capacitor section is sealed against moisture by plastic resin end seal bonded to the phenolic housing. End seal holds



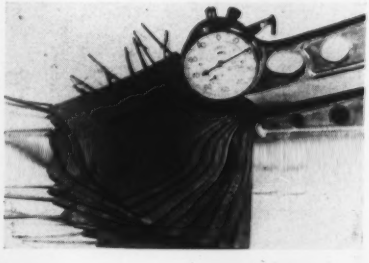
the two short leads at controlled distance from each other. Three stand-off feet raise the capacitor above the board, preventing the accumulation of moisture and dust around the circumference. Capacitors are impregnated with HCX, a hydro-carbon material that has high insulation resistance, low power factor and flat capacitance-change vs temperature characteristics. **Sprague Electric Co.**, 167 Marshall St., North Adams, Mass.

—Circle ITEM 86

Flexible Heating Elements

are extremely thin

Electro-Thin heating elements, insulated with silicone rubber and glass fiber, are 0.032-in. thick. They remain stable at temperatures to 450 F and can be made in any plane shape and in any size. Resistance variation is from 1.5 to



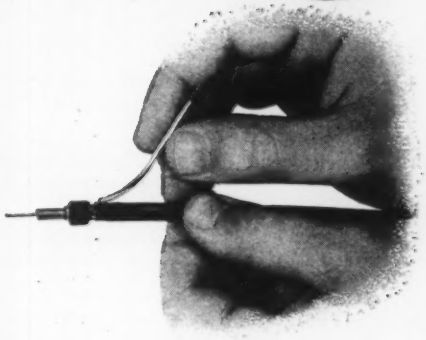
coaxial and shielded cable grounding

completed in 90 seconds with

HYRINGS

STRIP shield. Slip outer Hyring over insulated conductor. Slide inner Hyring under shield.

INSERT ground lead under outer Hyring and line up over the inner Hyring.



INDENT, assembly with single ratchet controlled compression stroke.

COMPLETED assembly, with Burndy Hylug attached to free end of ground lead.

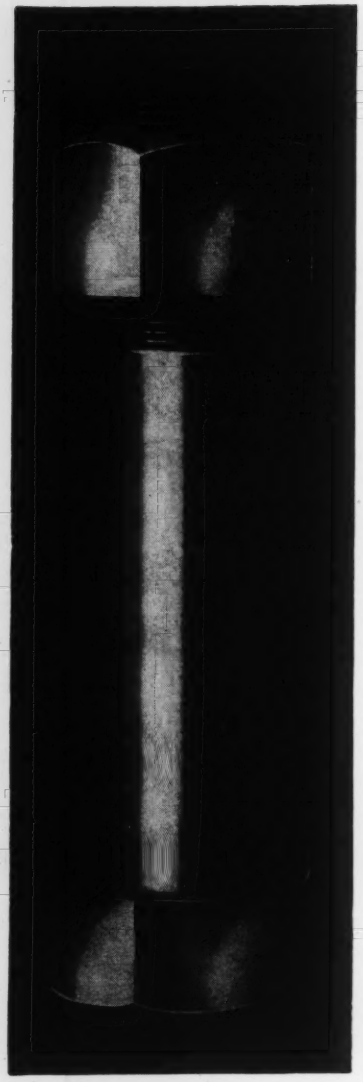
For details on color-coded BURNDY Hyrings, write for Hyring bulletin.

BURNDY

55-15

Norwalk, Connect. • Toronto, Canada • Factories: New York, California, Toronto • Export: Philips Export Company

—ITEM 257—



WHEN IT'S
***Special* BOLTS**
***and* STUDS**

Send your Specifications to

ERIE

40 years' experience in making special bolts, studs, nuts for specific job requirements.

10 INTEGRATED COMPANIES
BARIUM
STEEL CORPORATION
WORKING IN STEEL, ALUMINUM MAGNESIUM, FIBERGLASS

REPRESENTATION IN PRINCIPAL CITIES

—ITEM 258—

New Parts

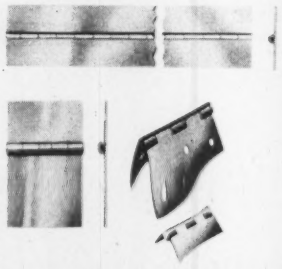
40 ohms per sq in. **Electro-Flex Heat Inc.**, 516 Asylum St., Hartford 5, Conn.

—Circle ITEM 87

Stainless Steel Hinges

continuous or butt types

Continuous or piano type hinges are available in open widths from 1 1/16 to 3 in., gages from 0.037 to 0.125-in. and standard length of 72 in., or 48 and 60-in. lengths. Pin sizes are 3/32 to ¼-in.; joints are ⅝ to 2 in. Plain or counter-



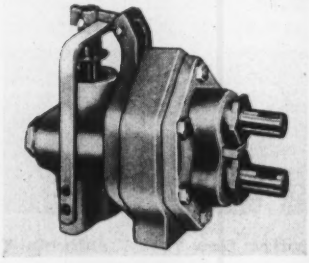
sunk holes can be made in specified locations. Butt hinges are available in gages from 0.050 to 0.125-in., widths and lengths of 1½ to 4 in., and pin diameters of ⅛ to ¼-in. Fixed and loose pin type hinges, both 2 x 1 in., are also available. **Star Stainless Screw Co.**, 699 Union Blvd., Paterson 2, N. J.

—Circle ITEM 88

Valve-Pump Combination

five spool type, three-way models for 1000-psi duty

Spool type, three-way valve and pump combination is designed for use with single-acting cylinders. The balanced valve is operable by cable or lever control for raising, holding and lowering. Rated for 1000 psi duty and tested at 2000 psi overload and 3000 psi shock load, the valve and pump combination has a built-in, adjustable pres-



Meet the abbot

Here's a little man you'll surely want to know.

Philosopher and physicist, mathematician and mechanic, designer and doodler, dreamer and detective — these are a few of the intriguing facets which make up the engaging personality of *the abbot.*

Space doesn't permit us to tell you all about him here. Suffice it to say that he's a dedicated soul (he professes no specific creed or faith) who has devoted his life to a study of the "Nature and Application of the Ball" . . . particularly our own DEEP HARDENED and TEMPERED carbon steel bearing balls.

We think you'll want to read the fascinating case histories which he will present in this space in the months ahead. But first, we'd like to send you a more detailed and comprehensive explanation of this little man's background and favorite study subject. So, just drop us a line and we'll send you a formal introduction to . . . *the abbot.*

THE ABBOTT BALL COMPANY
50 Railroad Place
Hartford 10, Conn.

ABBOTT

—ITEM 259—

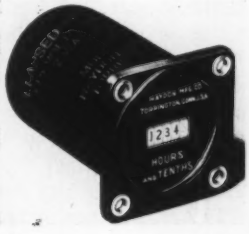
sure relief valve. Heavy-duty construction is employed in the units, which are available in five sizes with capacities from 8 to 22 gpm at 1000 rpm and 1000 psi. Single or double-shaft models are made to fit any rotation of power take off, and low-friction, shaft-sealed models are available for continuous operation. **Wisconsin Hydraulics Inc.**, 3165 N. 30th St., Milwaukee 16, Wis.

—Circle ITEM 89

Elapsed Time Indicators

for 115-v, 60-cycle ac

Miniature model 7010 running time meters accurately register accumulated hours of equipment operation. Two five-digit models are available to indicate time in 0.10-hour increments to 9,999.9 hours, or in 0.10-minute graduations to 9,999.9 minutes. The indicators



measure 1½ in. in diam and 2¾ in. long. They mount in front of or behind the mounting panel. Electrical connections are from the rear through solder type terminals. The indicators are housed in dusttight cases with synchronous motor drives, and they operate on 115-v, 60-cycle ac. **Haydon Mfg. Co. Inc.**, 245 E. Elm St., Torrington, Conn.

—Circle ITEM 90

Miniature Power Unit

withstands 2000 cps at 10 g

Series 257 miniature power unit, built so that mass is evenly distributed throughout the closely coupled housing, withstands vibrations of 2000 cps at 10 *g*. It provides a remote means of actuation, through flexible drive equipment, for screwjacks, gearboxes and controls. Torque ratings are: normal operating, 0 to 18 lb-in.; maximum

From DIALCO—New, Compact

OIL TIGHT

INDICATOR LIGHTS

for heavy duty industrial applications

OIL TIGHT
DUST TIGHT
OMNIDIRECTIONAL

Exceptionally Rugged!

Perfect oil-tightness is effected by retained oil-proof gaskets and the gasketed glass lens assembly.

These units have many heavy-duty features: *One-piece solid brass bushing, solid brass lens holder,* high impact phenolic insulation, *rugged binding screw terminals.* They install easily in a single 1" or 1 3/16" panel mounting hole. Other units available for 1 1/16" mounting hole. *A choice of 3 lens styles, 7 lens colors,* and other optional features provide adaptability. If you have an unusual problem, consult our engineering department.

DISCS with legends, behind flat lenses, deliver specific messages.

Illustrations are approx. actual size

DIALCO

OIL TIGHT INDICATOR LIGHTS

accommodate a wide range of Incandescent and Neon Glow Lamps. For neon, DIALCO offers an exclusive feature — *BUILT-IN RESISTORS* (U. S. Patent No. 2,421,321) for operation on 105-125 V, or 210-250 V. Simple external resistors are provided for all higher voltages. *EVERY ASSEMBLY IS AVAILABLE COMPLETE WITH LAMP.* For design purposes we will send :

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

CATALOG "L-200" gives you complete specs on DIALCO'S Oil-Tight Indicator Lights. Also available—a file of Special Catalogs on DIALCO Pilot Lights covering every indication requirement.

FREE — Brochure on *"Selection and Application of Pilot Lights".*

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

54 STEWART AVENUE
BROOKLYN 37, N. Y.
HYACINTH 7-7600

DIALIGHT CORP., 54 Stewart Ave., Brooklyn 37, N.Y.

☐ Please send Cat. "L-200" on Oil-Tight Lights
☐ "Selection" Brochure. ☐ Pilot Light Catalogs.

Name_____

Company_____

Address_____

City_____ State_____

—ITEM 260—

Compact new **Gast** rotary
No. 6 Air Motor delivers

TWO HORSEPOWER

. . . weighs only 17 pounds

Here's compact, light-weight power—offering many advantages as original equipment on your products! With the new 2 h.p. Model 6AM added to the line, Gast offers rotary air motors in five popular sizes from the 1/20 h.p. Model 1AM to the 4 h.p. Model 8AM.

To fulfill designers' needs, Gast also offers standard variations on some models, including foot or flange mountings for vertical or horizontal applications with direct or gear drive . . . special reversible rotation, etc. Well adapted for plant use or as original components, Gast Rotaries are explosion-proof, *variable in speed, burn-out proof* even when stalled—and low in first cost!

Wherever compressed air is available, they're a power source worth investigating! *Write for Model 6AM Bulletin 855*—or specify size that interests you. *Request "Application Ideas" Booklet too!* — Gast Manufacturing Corp., P.O. Box 117-P Benton Harbor, Michigan.

Original Equipment Manufacturers for Over 25 Years

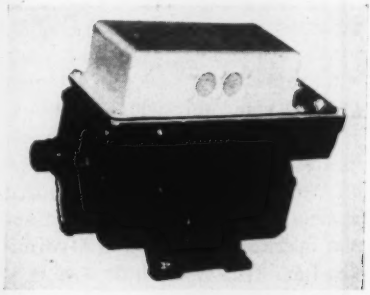
GAST ROTARY

- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

—ITEM 261—

New Parts



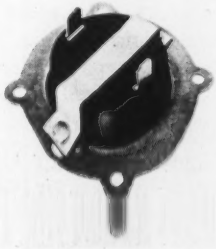
operating, 30 lb-in.; maximum static, 82 lb-in.; and ultimate static, 98 lb-in. Basic unit includes end-position limit switches and a radio noise filter. Power supply can be either 26 v dc; 115 v, single-phase, 400-cycle ac. or 200 v, three-phase, 400-cycle ac. **Lear Inc.**, Grand Rapids Div., 110 Ionia Ave., N.W., Grand Rapids, Mich.

—Circle ITEM 91

Bimetal Disk Thermostats

operate at 300 F

Snap-action bimetal disk thermostats for warm-air applications are Underwriters Laboratories-approved for operation to 300 F. Designated Stemco type D, the thermostats are rated 25 amp at 120-240 v ac noninductive; ½-hp at 120-240 v ac; and 345 va for pilot duty. Either exposed bimetal or enclosed bimetal styles are available, the latter being suitable for



use in atmospheres having a high lint or dust content. Either two or four-hole mounting and either spade type or No. 8-32 screw type terminals are available. Low resistance of heavy-duty fine silver contacts and metal-backed silver bridging contact construction provide cool operation under heavy loads. Thermostats operate with double contact break, which results in long operating life. The bimetal thermal element and the contact mechanism are housed separately. **Stevens Mfg. Co. Inc.**, 45 Plymouth St., Lexington, O.

—Circle ITEM 92

At last!

SPLIT V-RING PACKING

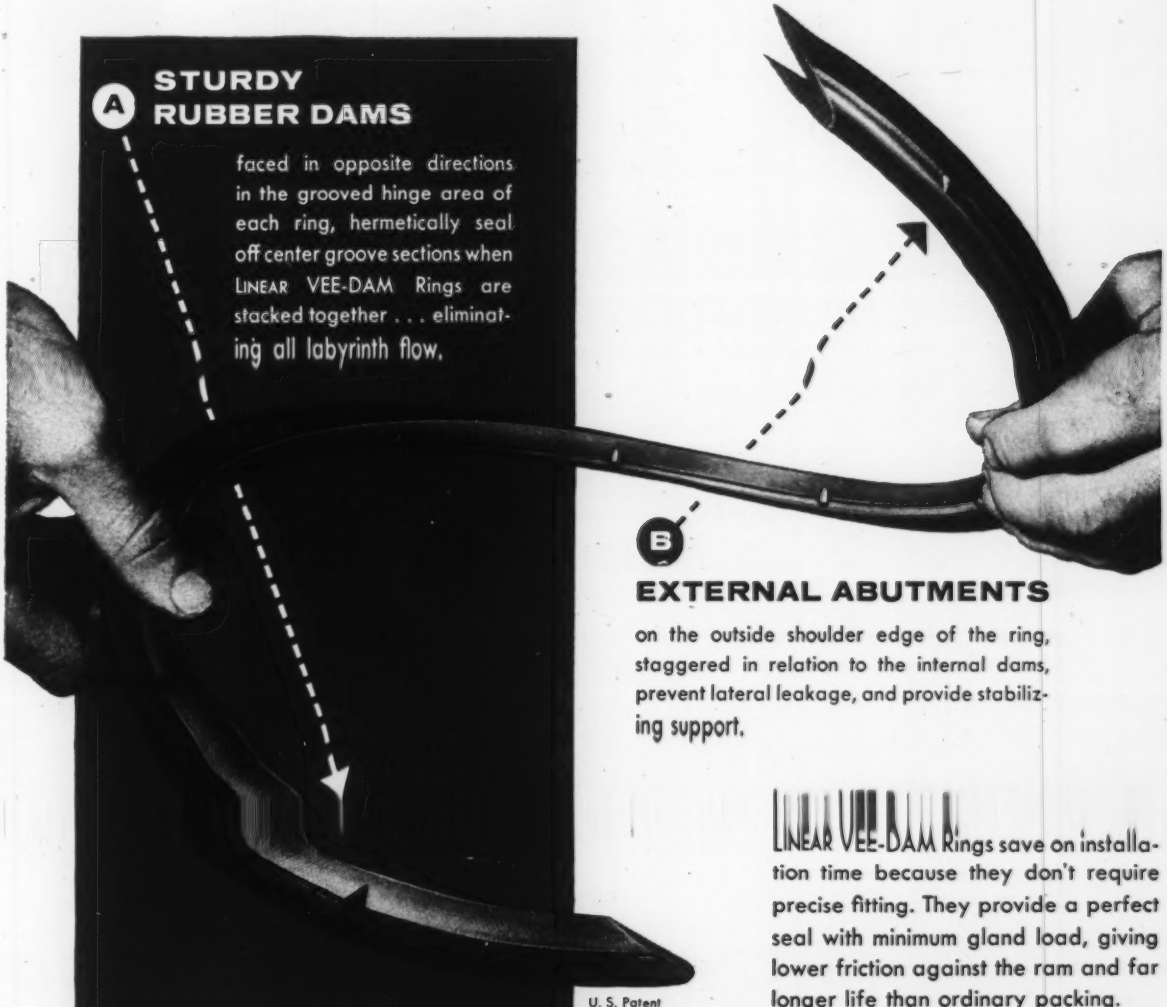
that's really LEAKPROOF!

LINEAR VEE-DAM RINGS

Labyrinth flow and lateral leakage are stopped by LINEAR'S uniquely designed, revolutionary VEE-DAM RINGS. Installation of these trouble-saving, long-lasting packings is virtually foolproof!

A STURDY RUBBER DAMS

faced in opposite directions in the grooved hinge area of each ring, hermetically seal off center groove sections when LINEAR VEE-DAM Rings are stacked together . . . eliminating all labyrinth flow.



B EXTERNAL ABUTMENTS

on the outside shoulder edge of the ring, staggered in relation to the internal dams, prevent lateral leakage, and provide stabilizing support.

U. S. Patent No. 2,665,151

LINEAR VEE-DAM Rings save on installation time because they don't require precise fitting. They provide a perfect seal with minimum gland load, giving lower friction against the ram and far longer life than ordinary packing.

Write or call for complete information on LINEAR VEE-DAM Rings in a choice of rugged, fabric-reinforced synthetic elastomers, tailored to your requirements.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

—ITEM 262—

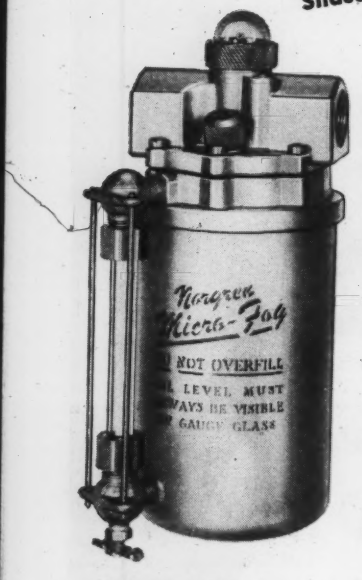
Now...

Norgren MICRO-FOG Lubricators

for 32, 200, 300 and 1000 BEARING INCH REQUIREMENTS

For Lubricating

Bearings • Gears • Ways • Chain Drives • Cams • Slides • Other Machine Components

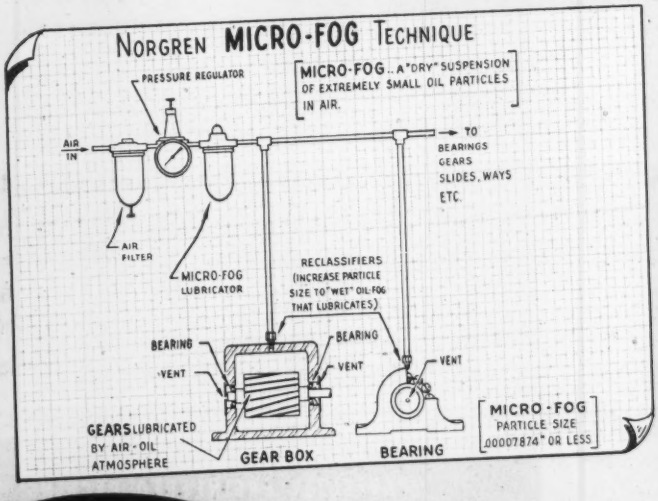


Model S3406-8S
1 quart oil capacity
300 bearing inch capacity
1 inch pipe size

You can now choose a specially designed Norgren MICRO-FOG Lubricator that has the bearing inch capacity that will provide the most effective lubrication for any machine.

Why Norgren MICRO-FOG Provides Better Lubrication

1. Norgren MICRO-FOG automatically supplies just the right amount of oil for lubricating machine components—no more, no less.
2. The advanced design of Norgren MICRO-FOG Lubricators makes possible complete machine tool lubrication with a minimum of air consumption.
3. Norgren MICRO-FOG remains suspended in the air stream and can travel many times farther than oil fog from conventional lubricators, and can be uniformly distributed to multiple lubrication points.
4. The delivery of Norgren MICRO-FOG to machine parts is precisely controlled. MICRO-FOG is delivered at a uniform rate regardless of the supply of oil in the reservoir.
5. Air-borne Norgren MICRO-FOG maintains a lower operating temperature for high speed parts—reducing wear, improving performance, increasing machine life.
6. The slight air pressure in bearing or gear housings prevents entry of foreign material.
7. 360° visibility of oil flow simplifies adjustment of oil feed rate, and provides visual assurance that the lubricator is operating.



C.A. Norgren CO.

3442 So. Elati, Englewood, Colo.

For complete information about Norgren MICRO-FOG Lubrication, phone your nearby Norgren Representative listed in your telephone directory—or

WRITE FOR NEW NO. 700 CATALOG

PRESSURE REGULATORS • AIR LINE FILTERS • LUBRICATORS • AIR CONTROL VALVES

—ITEM 263—

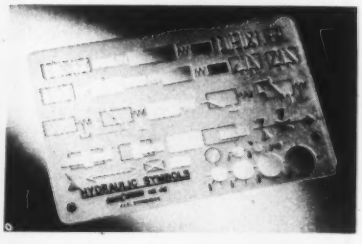
ENGINEERING DEPARTMENT

EQUIPMENT

Hydraulic Symbols Template

for JIC standards

No. 46 hydraulic symbols template contains precision milled cutouts of JIC standards of industrial hydraulic symbols for designing hydraulic circuits. Made of 0.03-in. matte finish plastic, it measures 7 x 4½ in. **Rapidesign Inc.**, P. O. Box 592, Glendale, Calif.



—Circle ITEM 93

Drafting Desks

modular units in 14 styles

Line of drafting desks is composed of 14 interchangeable basic models with various drawer arrangements and drawing board, desk top and reference table sizes. Drawing board sizes range from 26 x 40 in. to 43½ x 72 in. Linoleum-surfaced board is constructed of Reynocell which consists of two 0.035-in. gage aluminum sheets bonded to a honeycomb cellular core. It is mounted on nylon rollers, is counterbalanced for vertical height adjustment up to 12 in., and also can be adjusted and locked at any angle from 10 deg

Up to 40% higher tightening torques — a feature of new High-Torque

Unbrako socket set screws

RECOMMENDED SOCKET SET SCREW TIGHTENING TORQUES
(Inch-Pounds)

SCREW SIZE	UNBRAKO	SET SCREW B	SET SCREW C	MINIMUM DIFFERENTIAL %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
1/4	87	62	60	40
5/16	165	122	125	32
3/8	290	198	225	29
7/16	430	309	350	23
1/2	620	460	500	24
5/8	1225	1106	1060	11
3/4	2125	1540	1800	18
7/8	5000	3660	4600	9
1	7000	5025	6500	8

Compare UNBRAKO-recommended tightening torques with those of ordinary socket set screws and you readily see why you can set an UNBRAKO and then forget it. The reasons are simple. UNBRAKOS have deeper sockets, which give you better purchase with the wrench; rounded socket corners, which eliminate the sharp corners where cracks start; fully formed threads, which make them stronger; and knurled cup points, which keep them tight.

Let's see just how the development of fully formed threads make the new High-Torque UNBRAKO stronger. The metal is compressed into the closely knit grain structure that you see in the illustration. The grain flow follows the contour of the threads. There are no straight lines along which shear can occur. An UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Conversely, cut or ground threads have straight flow lines—lose thread form at root diameter.

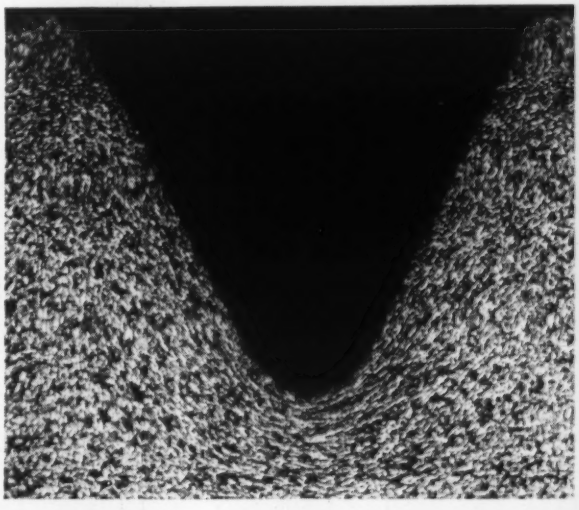
You can't buy a better screw than an UNBRAKO. And you can't get full *high-torque* performance without a "High-Titan" UNBRAKO Hex Key—the high-ductility, precision internal wrenching tool. See your authorized distributor today. Or write STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

STANDARD PRESSED STEEL CO.

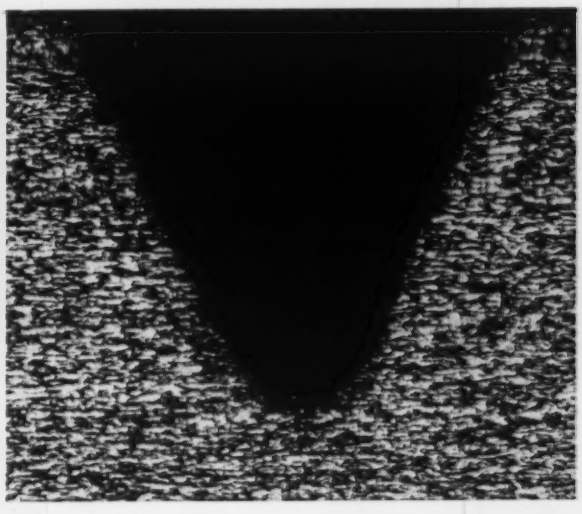
UNBRAKO® SOCKET SCREW DIVISION SPS

JENKINTOWN PENNSYLVANIA

UNBRAKO SET SCREW THREADS



ORDINARY SET SCREW THREADS



—ITEM 264—

Potter & Brumfield
RELAYS

Reduce Assembly Costs!

Whether your design calls for a large open relay or a miniature sealed one, P&B can supply it with any type of mounting or termination you desire. P&B's engineering foresight has anticipated your assembly problems; designing, versatility and flexibility into each of their relay types.

Let our engineering group with a quarter century of relay "know how" become part of your design team.

Send your specifications for recommendations and quotations.

Potter & Brumfield PRINCETON, INDIANA
SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY CO.

For quick delivery over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

Clip-on solderless | Pierced solder lug | Tube type octal plug | AN type connector

—ITEM 265—

Engineering Equipment

off vertical to 10 deg from horizontal. Desks and tables are constructed of heavy gage steel with channel-ribbed steel drawers and bonded plastic tops in green, gray or buff. The top drawer measures 36 in. wide, 3 in. deep and 24 in. front to back, and a 12 x 5 x 24-in. tool drawer contains a removable tray for pencils and drawing instruments. Models also are available with a 12 x 12 x 24-in. catalog drawer. **Emeco Corp.**, Hanover, Pa.

—Circle ITEM 94

Broken-Line Template

produces six combinations of dots and dashes

Dot and dash lines can be made with a pencil or ball-point pen by positioning a straightedge on this template and drawing the selected

line. Six different lines are included: long dash, short dash, long dash and dot, short dash and dot, long dash and two dots, and short dash and two dots. The transparent template is made of 0.0075-in. thick Mylar plastic. **Dot-N-Dasher**, P. O. Box 668, Cresskill, N. J.

—Circle ITEM 95

Portable Photocopier

has 9½ x 14¾-in. copying area

A new 12½-lb portable photocopy unit reproduces written, printed, typed, drawn or photographed matter, which is in color or black and white. Exposure is made by placing the original in the photocopier with a sheet of sensitized paper and turning on the switch. Copying surface is 9½ x 14¾ in. A storage compartment within the printer protects exposed negatives until they can be developed. The printer operates on either ac or dc. **Copease Corp.**, 270 Park Ave., New York 17, N. Y.

—Circle ITEM 96

Here's one reason why Michigan Tractor Shovels can move more yards per day, day after day...

USS MAN-TEN Steel provides extra strength and toughness in bucket and bucket boom

DESCRIBED AS "a bear for punishment and a hound for work" this big-yardage earth mover built by Clark Equipment Co., Construction Machinery Division, of Benton Harbor, Mich., is so engineered that every part contributes to high capacity operation and continuous, long-time service.

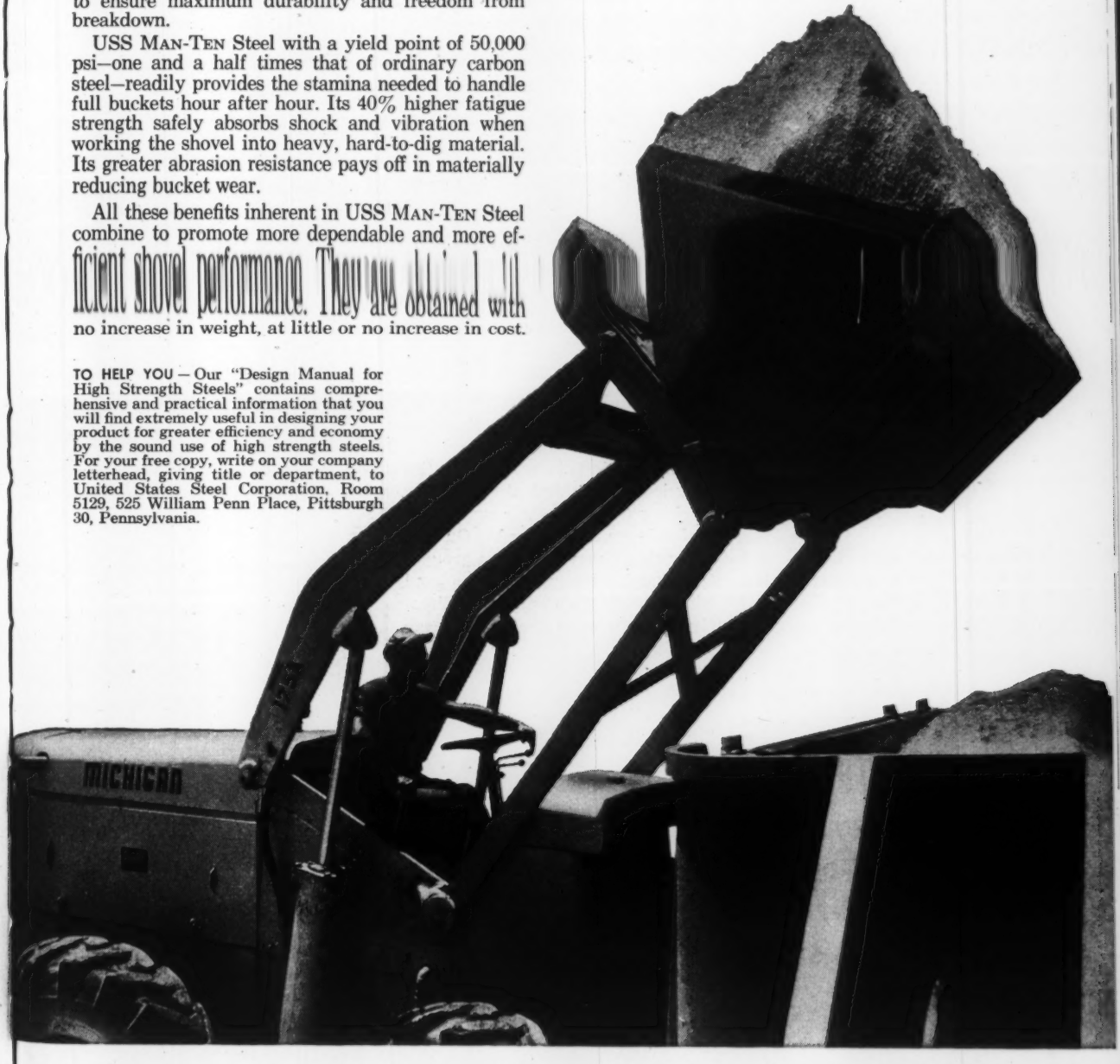
Use of USS MAN-TEN High Strength Steel in both bucket and bucket boom is typical of the care taken to ensure maximum durability and freedom from breakdown.

USS MAN-TEN Steel with a yield point of 50,000 psi—one and a half times that of ordinary carbon steel—readily provides the stamina needed to handle full buckets hour after hour. Its 40% higher fatigue strength safely absorbs shock and vibration when working the shovel into heavy, hard-to-dig material. Its greater abrasion resistance pays off in materially reducing bucket wear.

All these benefits inherent in USS MAN-TEN Steel combine to promote more dependable and more efficient shovel performance. They are obtained with no increase in weight, at little or no increase in cost.

TO HELP YOU — Our "Design Manual for High Strength Steels" contains comprehensive and practical information that you will find extremely useful in designing your product for greater efficiency and economy by the sound use of high strength steels. For your free copy, write on your company letterhead, giving title or department, to United States Steel Corporation, Room 5129, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

Contact our nearest office and let us show you how you can apply USS MAN-TEN or our other High Strength Steels—USS COR-TEN and USS TRI-TEN—in place of carbon steel, to make your equipment *better*—able to do more work—able to last longer—with fewer stops for service and maintenance.



UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS MAN-TEN High Strength STEEL

USS

6-296

UNITED STATES STEEL

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ELECTRONIC
ENGINEERING
GIVES
PRECISE

SERVOSPEED
MOTOR CONTROLS

- DIGITAL CONTROL
- ANALOG CONTROL
- SYNCHRONIZING
- SEQUENCE CONTROL
- VARIABLE SPEED

Write or call for further data

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DIV. of ELECTRO DEVICES, Inc.
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ARmory 4-8989

—ITEM 267—

Stress Relief

OUR old friend, J. P. Henderson, is not too mellow to resist the challenges he detects in the passing scene. Here he charges into battle on

The Engineer and the Egg Head

"I see," a friend told me recently, "that a new society is being formed by some engineers and fuzzy thinkers to make the technical man aware of and responsible for the social value of his developments." That triggered release of some ideas I've been harboring for some time.

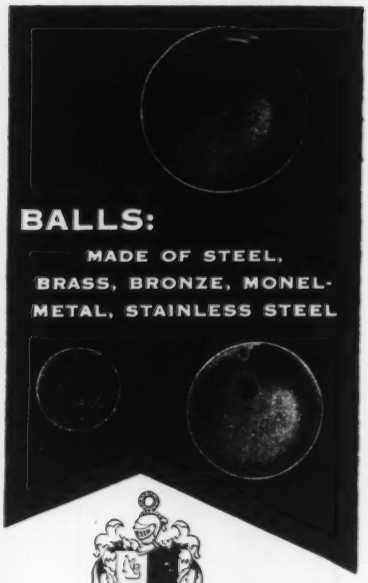
Two Pastures

In continued contact with many people, I've been mentally classifying them for years as belonging on one side or another of an imaginary fence. Over in this pasture are the technical people and others whose thinking (when in their own field) is fundamentally sound. On the other side, there is no firm ground. Quicksand, swamp, muck, and winds blowing in all different directions characterize the area. Fuzzy thinking marks the group of people that belong on that other side of the fence.

According to my way of thinking, too many of the liberal arts boys, the social "scientists" and the professional followers of *belles-lettres* are feeding in that pasture.

Years ago when those folk were concerned chiefly with attempting to count their own fingers and mutually admiring the new art forms they had developed by smearing colored clay on pieces of canvas, they were relatively less dangerous. Today, seeing all of the meaningful and effective activity in the scientific pasture, they are trying to horn in and tell us what we should do and how to do it.

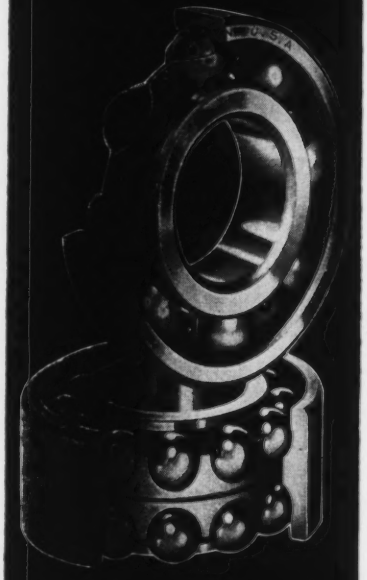
"Look," they shout at us, "all of your technical activity is ruining our world. You will destroy everything. Man is a slave to the ma-



HOOVER

The Aristocrat of Bearings

BALL BEARINGS:
AMERICA'S ONLY
BALL BEARING WITH
HONED RACEWAYS



HOOVER BALL
AND BEARING COMPANY
ANN ARBOR, MICHIGAN

—ITEM 268—

chine. You have standardized everything to a dull mediocre level.

"Look," they say, pointing to their own pasture, "Look at those paintings, look at this book. You don't understand any of them do you? You are really only trained baboons!

"Since you don't understand any of these things, and don't have the broad view, it is going to be necessary for us to direct your activities."

And so from their windy pasture there are more and more of them shouting directions across the fence —pundits, politicians, and panderers.

The trained man has sat back too meekly and too long under such charges. Accused of being an illiterate, he rarely answers back. He appears unaware of his own powers and his own glories. Or, if he is aware of them, he is not vocal enough in taking his own part and upholding science as a cultural achievement.

I'd like to focus on the cracks in the egg head and supply verbal ammunition in defense of the engineer. Just call me "The Voice."

Social Good?

First I'd like to take aim at those who suggest that technical advances can be slowed down or censored for "social good."

You may be old enough to remember that, during the Great Depression, a group of our serious (and fuzzy) thinkers proposed a technical holiday.

"The engineer has ruined our economy and produced technological unemployment," they said. "We must put a stop to his developments."

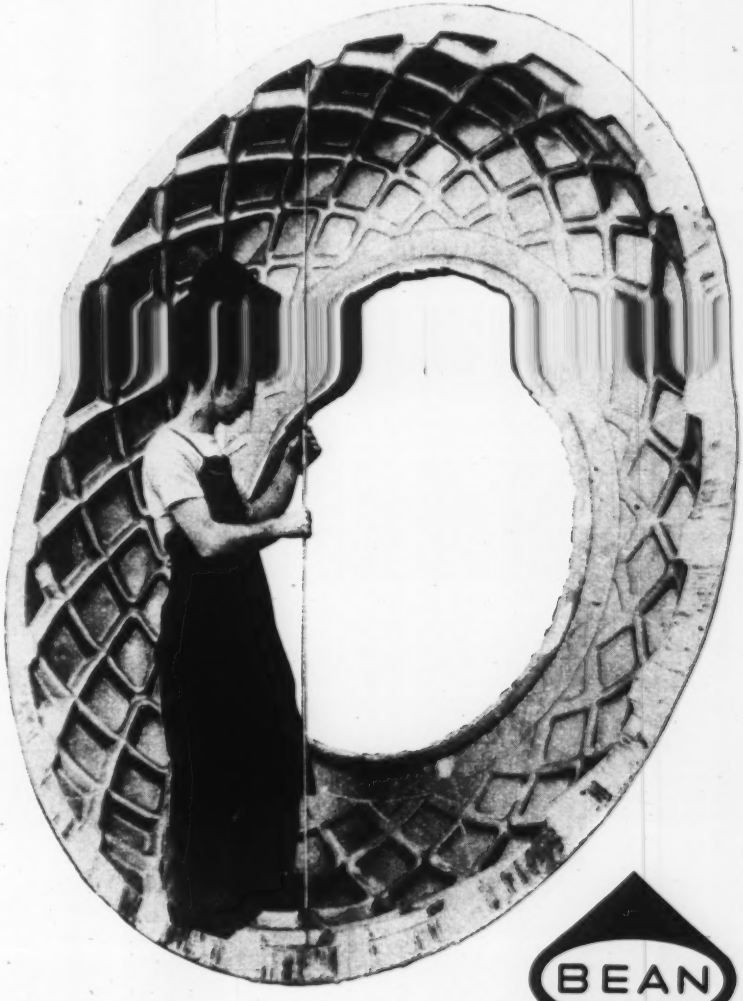
Are there any self-deluded economists today who do not believe that the true wealth of a nation is in what it can produce? High production with a minimum of human effort is generally recognized now as the desirable thing. But not then; and that of course is one of the charming things about those fuzzy thinkers in the egg-head pasture. Generation after generation they face the same problems and ask the same questions. But each decade they have a different answer.

Few buyers are as particular about aluminum castings as tire makers. Their tire molds must be extremely accurate, dense, and concentric. Intricate tread designs must be reproduced faithfully.

Morris Bean & Co. recently cast a pair of the world's largest tire molds . . . 9 foot diameter held to ±.060" . . . weight, 2000 lbs. Tire molds, waveguide and fluid flow castings are produced in quantity, using the Antioch Process*. If your design includes aluminum castings with high performance requirements, send us a part print for recommendations.

Morris Bean & Company
Yellow Springs 2, Ohio
*Send for technical booklet about the Antioch Process for aluminum casting.

one-ton precision casting



BEAN

—ITEM 269—

CHEMICAL COMPOSITION OF HARD CARBIDE INGREDIENTS OF KENNAMETAL

	Tungsten Carbide (WC)	Titanium Carbide (TiC)	Tungsten-Titanium Carbide ($WTiC_2$)	Tantalum Carbide (TaC) with less than 5% CbC
Tungsten (W)	92.50% (min)		67.00-71.00%	
Titanium (Ti)		79.80-80.20%	18.00-21.00%	
Tantalum (Ta)				93.45-93.65%*
Carbon (C)	6.05-6.15%	19.20-19.60%	9.20-9.40%	6.35-6.55%
Columbium (Cb)				5.00% (max)

*Including CbC

MAXIMUM IMPURITY CONTENT

Free Carbon	0.05%	0.20%	0.05%	.....
Fe	0.15%	0.40%	0.10%	0.10%
Mo	0.10%	.....	0.30%	.....
Ni	.....	.....	0.20%	.....
Cb+Ta	0.50%	.....	0.50%	.....
Ti	0.20%	.....	.....	0.50%
Si	0.10%	0.10%	0.10%	.....
Mn	0.10%	0.10%	0.10%	.....
V	.....	0.10%	.....	.....
Zr	.....	.....	.....	0.20%
Sn	.....	.....	.....	0.10%
W	.....	0.20%	.....	0.30%
Cr	.....	0.10%	.....	.....
N_2	.....	0.30%	.....	.....

These characteristics make KENNAMETAL* a unique material

Often, what is required to get an idea off the drawing board into production is a material that provides exceptional physical and chemical properties. Such a material is Kennametal . . . the hardest metal made.

The combined properties that Kennametal provides . . . shown in the accompanying tables . . . make this material stand uniquely alone. Each of the many grades of Kennametal provide a different combination of hardness, strength, and resistance to deflection, chatter, torque and vibration, erosion, abrasion, cavitation, corrosion, annealing, oxidation and shock.

Perhaps one or a combination of these characteristics is just what you need to get YOUR idea into production. We invite you to send for additional information about Kennametal. Write to KENNAMETAL INC., Latrobe, Pennsylvania, and ask for a copy of Booklet B-111. 7293

Kennametal is the registered trademark of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum.

RANGE OF PHYSICAL PROPERTIES OF VARIOUS GRADES

Specific Gravity gms/cc	11.90-15.15
Thermal Conductivity (cal/°C/cm/sec)	.068-.207
Electrical Conductivity (% of Copper Standard)	4.3-10.0
Coeff. Thermal Expansion (×10⁻⁶/°F up to 1200°F)	2.5-4.0
(×10⁻⁶/°C up to 650°C)	4.5-7.2
Magnetic Permeability (μ Induction)	1.5-3.0

RANGE OF MECHANICAL PROPERTIES OF VARIOUS GRADES

Hardness (Rockwell A)	85-93
Hardness (Rockwell C)	67-82
Hardness (Knoop-K100)	1700-2100*
Transverse Rupture (psi)	175,000-385,000
Young's Modulus of Elasticity (psi)	61,600,000-94,300,000
Compressive Strength (psi)	518,000-800,000
Torsional Strength (Shearing Stress psi)	100,000-186,000
Tensile Strength (psi)	To 150,000

*Partial Range

INDUSTRY AND KENNAMETAL ...Partners in Progress

Stress Relief

If they had faced the facts, during that depressed period, they

"The problems of finance and distribution have grown up beyond us. Technology and production have outstripped our knowledge. On our side of the fence we must learn more, as our scientific friends have."

But they didn't say that, and only by reading between the lines could one determine that such was the case.

Today, in a slightly changed form, the same kind of problem appears. The scientific world is belabored to develop a conscience, and if you as a technical man don't have one, some of our egg heads would gladly show you what you should or should not do.

It seems that new developments can be used for evil purposes. The notable (but not the only) example is the nuclear research that produced The Bomb. Therefore any technical man should ask himself on any development: "Will this idea be used for social good, or will some evil person misuse it?"

Tommy rot! How can anyone foresee all of the possible uses that will be made of any new idea—whether it is a major advancement or only a new little brick in the vast wall of knowledge?

Use Beyond Inventor's Control

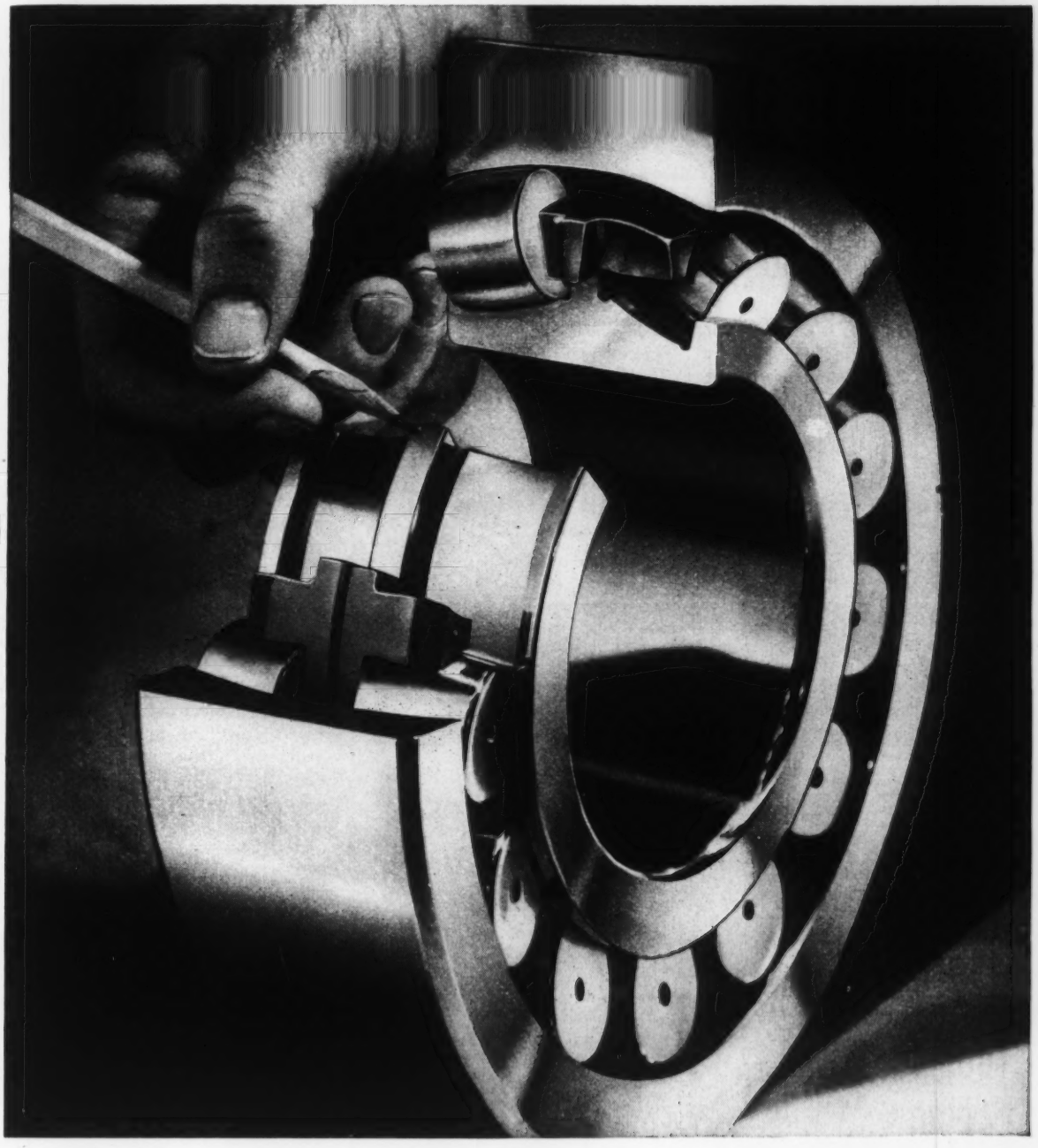
It is possible to imagine a society so simple in its organization that the man who invents something, develops it in all of its manifestations, prepares it for the market, writes its advertising, establishes its sales policies and then peddles it to the trade. Such a man is in a position to determine whether a new idea is essentially good or bad (in a social sense) and could control its use. He could be held morally responsible for the social value of his technical development that started the whole business.

But our industrial system has not operated like that for many a year. And its complexities are growing constantly with each specialist contributing only a little part to the whole.

Can You Stop Invention?

Suppose that I, as a scientifical-

TORRINGTON *SPHERICAL ROLLER* BEARINGS



"This flange guides the rollers to peak performance!"

The center flange on the inner raceway of the TORRINGTON Spherical Roller Bearing positions the rollers to handle thrust loads. This accurate positioning also assures radial stability of the rollers under heavy loads—even at continuous high speeds and under conditions of misalignment.

This superior design feature is only one of many advantages you get when you specify TORRINGTON. For example, you get the service of TORRINGTON'S experienced engineers, who will help you with design and maintenance problems—or design custom bearings for special applications.

For long, low-maintenance service in heavy-duty applications, order TORRINGTON Spherical Roller Bearings. They're available from stock with either straight or tapered bore, for shaft or adapter mounting.

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District offices and distributors in principal cities of United States and Canada

90th ANNIVERSARY

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller
Needle • Ball • Needle Rollers

—ITEM 271—

ILSCO CONNECTORS

MAKE YOUR PRODUCT PERFORM BETTER

TERMINAL BLOCKS

CAN NEUTRAL
60 100 & 200 AMPS

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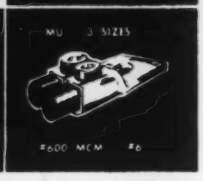
MU 3 SIZES
#600 MCM #6

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PURE COPPER	RE-USABLE
100% CONDUCTIVITY	ALL WIRE SIZES
COOLER OPERATION	ECONOMICAL

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80-PAGE CATALOG

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—ITEM 272—

Save Draftsmen's Time

YOUR TYPIST CAN DO THE JOB BETTER

The Vari-Typer lettering machine is the fastest and most economical method of lettering specifications on tracings and drawings. It is four to five times faster than hand lettering and is operated by an office typist. Every letter and figure is uniformly clear and distinct. Instantly changeable type, with hundreds of different styles to choose from in sizes ranging from 6 point to 18 point. Write today for information.

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—ITEM 273—

Stress Relief

ly trained man, have the glimmer of an idea. I want to follow it up and I am in a position to do so, either through inherent authority or by permission. But instead I stop and ask myself: "Will some evil person use this idea or the developments that result therefrom in an antisocial manner?" If the answer is "Yes," then presumably I drop the whole thing.

Have you ever had a burning idea that you had to investigate? Have you ever worked on a problem, gotten so far, had a bright idea that you'd like to follow up, and then been able to stop yourself from going right on with it? Of course not, and any attempt to curtail scientific invention or development would only result in drawn shades and locked doors in our laboratories.

What They Should Say

The eggs heads would do well to look toward their own group and let science advance. If they were clear-headed enough they could say:

"If social evils result from technical progress, it is because the men in our own group are without conscience, or are too ill-trained to see the consequence of their attitude.

"The trouble is not that science has gone too fast, and unchecked. We, the egg heads, have gone too slowly."

That's what they should say.

—J. P. HENDERSON

"But you told me to give this new device a field test."

(Advertisement)

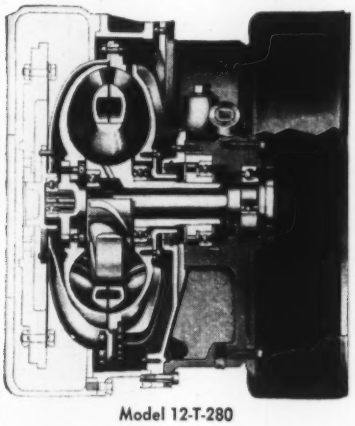
Fuller announces 3 new torque converter couplings

. . . designed for a wide variety of industrial applications

Three new Fuller Torque Converter Couplings nominally rated at 280 foot pounds of torque are now available for increasing work capacity in a wide variety of industrial applications.

The Fuller Industrial Torque Converter Couplings consist of three simple elements; impeller or pump, runner, and reaction member. With single stage two phase design, the reaction member is mounted on an overrunning clutch which permits rotation with the runner, and operation as a straight hydraulic coupling for high efficiency. The change from 2.1:1 conversion stage operation to straight hydraulic coupling stage and back is automatic, depending only upon the amount of torque required in the drive line.

Advantages of the 2.1:1 torque multiplication and smooth fluid coupling operation provided by the new Fuller Torque Converter Couplings include obtaining faster work cycles . . . with less downtime and less maintenance. Typical applications are: fork lift trucks, winches, loaders, self propelled cranes, truck cranes, lumber carriers . . . and diesel and gasoline locomotives.



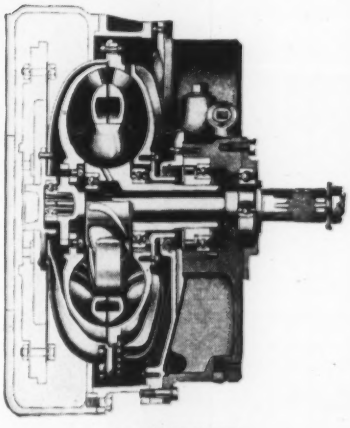
Model 12-T-280

The New 12-T-280

This new Fuller Torque Converter Coupling incorporates an SAE No. 3 clutch housing behind the converter. The output shaft is flanged for attachment of a single plate clutch flywheel.

The New 12-U-280

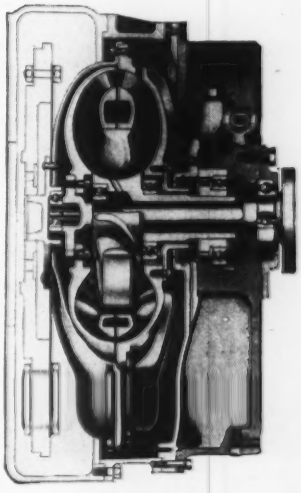
The Model 12-U-280 Fuller Torque Converter Coupling incorporates a 1½" ten-spline shaft on the output end, without clutch housing, for straight line drives through a universal joint.



Model 12-U-280

The New 12-H-280

A new model which incorporates a flange at the output shaft, for attachment of industrial type couplings.



Model 12-H-280

For Tough Tasks— It's Fuller by Far!

Where frequent start-and-stops, or heavy, intermittent shock loads threaten to overwork engines, transmissions, axles, brakes and tires . . . use the fluid cushioning of these new Fuller Torque Converter Couplings to *absorb* and *eliminate* shock loads.

Torque demand is matched to the load through the 2.1:1 torque multiplication of the converter . . . automatically changing to fluid coupling as the load is reduced. These new Fuller Torque Converter Couplings *keep* engines operating in the high rpm range under all conditions of vehicle load and speed.

See your equipment dealer *today*. Specify Fuller Torque Converter Couplings in your new equipment for better performance.

FULLER MANUFACTURING COMPANY
TRANSMISSION DIVISION • KALAMAZOO, MICH.

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

—ITEM 274—

MARK-TIME helps designers meet RIGID Specifications

Manufacturers with *unusual* timing problems have found that MARK-TIME engineers come up with the answer in quick time. For *your* new designs turn to MARK-TIME, with 25 years of experience in the design and manufacture of timing devices, for the *right* control unit.

MARK-TIME 25th YEAR

M. H. RHODES, INC.
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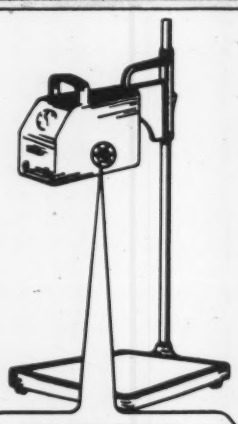

MARK-TIME
makes the difference!

Atom-Powered X-ray Unit

A compact Mark-Time timing mechanism controls the radio-active exposure interval of this new light-weight atom-powered X-ray unit. In the Mark-Time unit, the toggle that releases the shutter is constructed as a lock, allowing the timing mechanism to be pre-set and put in operation by a flick of the toggle. Further proof that where precise timing, weight and size are critical, MARK-TIME makes the difference.

MARK-TIME representatives in cities throughout the U.S.

—ITEM 275—

Another of the Reasons Behind Brad Foote Quality—

TOOTH SPACING

• 99% of gear drawings do not specify tooth spacing. For most applications, industry generally believes that competent gear manufacturers, working by standard AGMA practices, will produce gears within the limitations required for easy assembly and good load transmission.

• Occasionally, however, on very precise jobs you may find it necessary to specify extreme accuracy of tooth spacing and nonadjacent tooth spacing. Applications such as radar mounts, timing mechanisms, indexing mechanisms—all may require closer tooth spacing tolerances than are obtainable with average equipment in the hands of regular gear manufacturers.

• BRAD FOOTE welcomes precision jobs like these. We can add to highly specialized equipment specific experience in meeting this, as well as many other demanding requirements for special gear production.

• Prove to yourselves the savings that BRAD FOOTE quality can mean. Let us quote on the gear requirements for your next program.

BRAD FOOTE MAKES ALL TYPES OF GEARS—
IN A COMPLETE RANGE OF STYLES AND SIZES

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Phone SPalding 1-4400 Pittsburgh 25, Penn.

—ITEM 276—

THE ENGINEER'S Library

325193

Recent Books

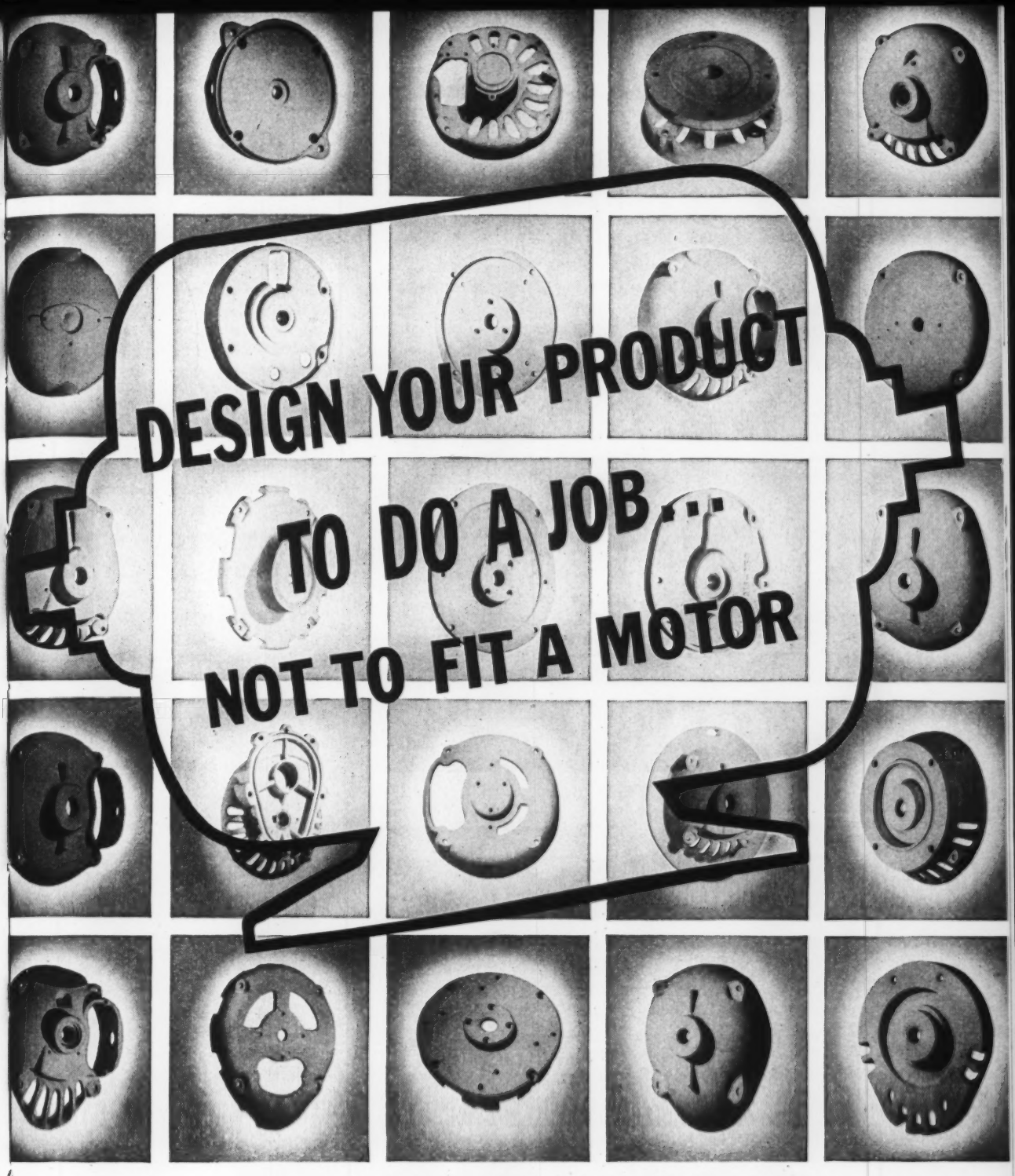
The New American Machinist's Handbook. *Edited by Rupert LeGrand;* 1572 *pages,* 5¼ *by* 8 *inches, clothbound; published by McGraw-Hill Book Co., New York; available from* MACHINE DESIGN, $11.00 *postpaid.*

Information in the earlier editions of *The Machinists Handbook* form the basis and precedent for this new reference volume. Extensively rewritten and rearranged to bring its contents up to date, the new handbook covers the field of machining in 45 sections grouped in 11 parts. The parts cover methods of machining, metal forming and assembly; materials and metals finishing; inspection of machined parts; fastening devices; tool engineering, drafting practice, machine tool standards and power transmission equipment. Condensed mathematics and reference tables are included.

•

Elements of Machine Design. *By Emanuel Rosenthal, Brooklyn Technical High School, and George P. Bischof, East New York Vocational High School; 233 pages, 6 by 9 inches, clothbound; published by McGraw-Hill Book Co., New York; available from* MACHINE DESIGN, $4.50 *postpaid.*

The purpose of this book is to analyze problems in the proportioning of machine parts and to present simple and rational solutions. The text has been simplified primarily to meet the needs of students in technical institutes, technical high schools and trade schools. Beginning with a survey of the metals of industry and their properties, the authors then treat problems in applied mechanics, power transmission, and design stresses for dynamic loadings. The



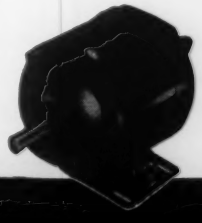
. . . one way is with *Customized* end bells like these

PROBLEM: To design your product for maximum economy of manufacture while maintaining the utmost in performance . . . and to do this with modern and attractive styling.

SOLUTION: Bring your product design to Jack & Heintz. Let J&H engineers custom-build a motor to be an integral part of your particular product.

Whether your prime consideration is special mechanical features, exacting electrical specifications, the ultimate in styling, or economy of manufacture, you'll find J&H engineers will work to satisfy your requirements. Pictured here are examples of end bells specially designed for a few of our customers . . . each pleases the eye, yet each incorporates necessary functional characteristics of a Jack & Heintz *Customized* Motor.

Avoid compromising your product design by taking advantage of an engineering philosophy geared to solve your special motor needs. Send for our free booklet, *How Jack & Heintz Customized Electric Motors Can Improve Your Product.* Write Jack & Heintz, Inc., 17626 Broadway, Cleveland 1, Ohio.



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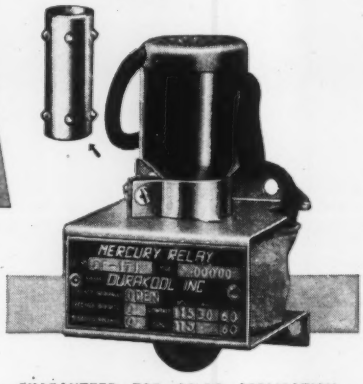
Customized JACK & HEINTZ *ELECTRIC MOTORS*

Mr. Design Engineer:
We offer you the Relay that eliminates controlled timing problems

PRE-SET TAMPER PROOF
TIMER-RELAY



This steel clad, factory set, tamper proof Durakool timer-relay is practically non-breakable. Operating life multiplied 5 to 6 times by new plunger construction features. Any combination of operate-release-time delays from 0.15 sec. to 20 sec.— either normally open or normally closed action.

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★ Non sticking
★ Practically "fail safe"
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Durakool ALL-STEEL MERCURY *Timers*

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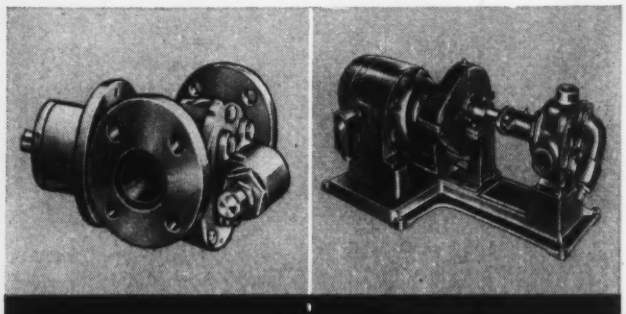

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—ITEM 279—

The Engineer's Library

main part of the book is devoted to the design of basic machine parts. Practical problems are presented at the end of each chapter.

TE/a
013

Information Processing Equipment. *Edited by M. P. Doss; 270 pages, 5¾ by 9 inches, clothbound; published by Reinhold Publishing Corp., New York; available from* MACHINE DESIGN, *$8.75 postpaid.*

Equipment used in the preparation, reproduction and utilization of written information is described and illustrated in this book. Chapters written by authorities in the fields discussed cover latest developments in electric and automatic typewriters, calculating machines, stencil and hectograph equipment, collating machines, lenseless copying with sensitized paper, microcopying, letterpress and offset printing, dictating and recording machines, punched cards and machines for handling numerical data.

New Standards

Ring-Joint Gaskets and Grooves For Steel Pipe Flanges. *ASA B16.20-1955; 11 pages, 8½ by 11 inches, paper bound; published by and available from American Society of Mechanical Engineers, 29 W. 39th St., New York 18, $1.00 per copy.*

First published in 1952 under its present number, this revised standard includes an additional ring-joint gasket size originating with the American Petroleum Institute. The standard includes types and sizes, material, dimensions, tolerances, finish, identification and marking of ring-joint gaskets and grooves covers.

Association Publications

Review of Current Research and Directory of Member Institutions, 1955. *352 pages, 5¾ by 9 inches, paperbound; published by the Engineering College Research Council of the American Society for Engineering Education; available from Renato*

YOU GET WHAT YOU PAY FOR

VICE-PRESIDENT, THE CINCINNATI GEAR CO.

John Ruskin knew what he was talking about when he wrote: "There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper, and the people who consider price only are his prey." Just as this applies to ice cream or magnetos or wool socks, so does it apply to gears.

This "cheap price" paid for a necessarily cheap product may not prove to be such a bargain if the ultimate cost of using such a product can be determined. In the case of gears, each of the following points directly affects *final* cost: 1. The "price tag" on the gear itself. 2. Extra assembly time wasted in fitting and salvaging "off color" gears. 3. Lack of reasonable service life. 4. Excessive noise. The first point is obvious, and the second becomes so upon observation: for not until the gears have been assembled, "run off," and passed by inspection can the direct cost of the gears be determined. Often part or all of the potential savings on "price" are lost (often without even being recognized) on the assembly floor. Points three and four represent more insidious and hard-to-measure costs—but costs that can be even more damaging, for they will be measured by your *customer*, and can easily spell the difference between repeat orders or a customer lost for good.

Thus the *ultimate cost* of a gear that appears to be a bargain may, in the final analysis, actually be exhorbitant. That's why it can *pay* you to buy *good* gears, custom made for your specific application—gears made by The Cincinnati Gear Company.

THE CINCINNATI GEAR CO.
CINCINNATI 27, OHIO

"Gears—Good Gears Only"

—ITEM 280—

The Engineer's Library

Contini, secretary of the council, New York University, University Heights, New York 53, $2.00 *per copy.*

For each of 105 American universities and colleges this volume lists the research officers, research policies, numbers of research personnel, research income and expenditures, and the subjects of active or scheduled research projects grouped according to general technical field. Representative classifications are electrical engineering, mechanical engineering, engineering mechanics and materials, and engineering physics. In all branches of engineering, 7500 projects are reported. The book is brought up to date and republished in odd-numbered years.

•

High Strength Low Alloy Steel. 45 *pages,* 8½ *by* 11 *inches, paperbound; available from American Iron and Steel Institute,* 350 *Fifth Ave., New York* 1.

This section of the AISI Steel Products Manual covers description, metallurgical aspects, manufacturing practices, size standards and chemical compositions of high-strength low-alloy steel as produced in the form of sheets, strip, plates, structural shapes, bars and bar size sections.

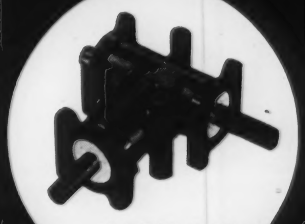
•

Proceedings of the Symposium on Printed Circuits. 122 *pages,* 8½ *by* 11 *inches, paperbound; published by and available from Engineering Publishers, GPO Box* 1151, *New York* 1. $5.00 *per copy.*

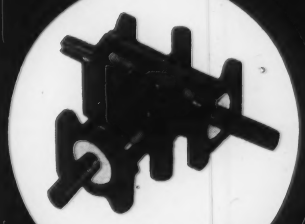
The Symposium was held at the University of Pennsylvania, Philadelphia, in January 1955, and was sponsored by the Radio-Electronics-Television Manufacturers Association with the participation of the Institute of Radio Engineers.

The published proceedings contain the full versions of the symposium technical papers. They are divided into general groups which cover product design, reliability and serviceability, management

ANGLgear



MODEL 340



MODEL 350

...but price stays down!

3 hp at 1200 rpm! That's the new rating of the rugged 2 and 3-way ANGLgear models shown above. And — we repeat — there is no change in purchase price.

The expanding ANGLgear line — now including 1/3, 1 and 3 hp units available with 1-1 or 2-1 gear ratio and with either 2 or 3-shaft extensions — enjoys wide acceptance in many fields. It's sold only through your local distributor. See our literature in the product design section of Sweet's Catalog.

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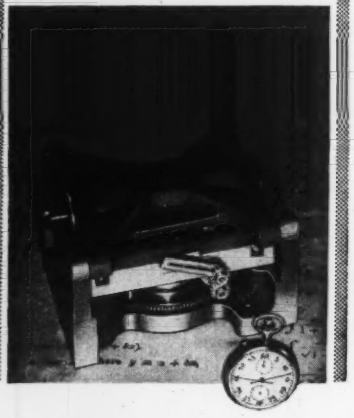

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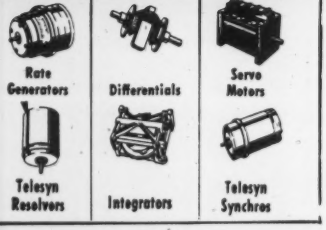
Ford Instrument's standard components



—ITEM 282—

The Engineer's Library

considerations, techniques of producing printed wiring boards, printed components and components for use with printed wiring, production techniques and manufacturing methods.

•

Tool Steels. 72 pages, 8½ *by* 11 *inches, paperbound; available from American Iron and Steel Institute,* 350 *Fifth Ave., New York* 1.

This section of the AISI Steel Products Manual covers manufacturing practices, identification and type classifications, selection, tolerances for dimensions, allowances for machining and decarburization, and macroetch inspection guides for tool steels.

•

Ultra High Strength Steels in Aircraft Application. 76 *pages,* 8½ *by* 11 *inches, paperbound; published by the Society of Automotive Engineers; available from Reader Service Station, The International Nickel Co., Inc.,* 67 *Wall St., New York* 5.

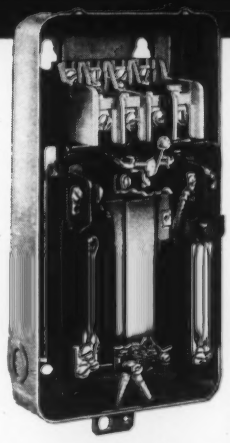
This booklet presents six papers discussing a new nickel alloy steel capable of providing tensile strengths up to 300,000 psi. Subjects covered include heat treatment, processing and design considerations.

Manufacturers' Publications

WILCO Blue Book of Thermometals, Electrical Contacts, Composite Metals and Special Alloys. *Edited by Victor G. Mooradian;* 192 *pages,* 8½ *by* 11 *inches, paperbound; published by and available from the H. A. Wilson Co.,* 2655 *U. S. Route* 22, *Union, N. J.; write to H. A. Wilson Co. for additional information.*

This book is intended to be a complete reference for engineers concerned with the four groups of materials indicated by its title. The book lists hundreds of materials, giving their properties and applications. It also provides charts, formulas and diagrams for research and design in the field it covers. The section on special alloys describes Ni—Span C.

Another FURNAS "FIRST" "DUAL SEAL" COILS



FEATURES

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- **Excellent Heat Dissipation**
- **Dimensionally Stable**
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- **Non-combustible**

Furnas Electric again leads the field —this time with magnetic controls with Dual Seal coils for longer control life. Dual Seal molded coils are moisture and fungus resistant, dimensionally stable, age resistant, will not support combustion and have high dielectric strength. Their mechanical properties eliminate the damage often caused by vibration or impact.

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Coil changing is virtually eliminated and stocking of coils simplified with the new Dual Seal dual voltage coils. For example, on 3, 7½ or 10 hp. starters, one 220-440 volt Furnas Electric coil is used where six are normally required.

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FURNAS ELECTRIC COMPANY
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—ITEM 283—

New Machines

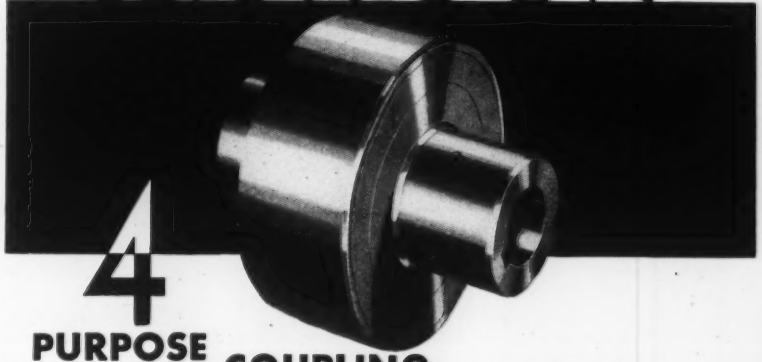
Metalworking

Drill Grinder: Model DV Sterling machine grinds drills to included angles from 90 to 140 deg. Angle adjustment is made by a positive-locking handwheel which holds the head at any angle. Built-in clearance gage indicates the clearance angle being ground on any size drill. The grinder accommodates two, three and four-flute drills from ⅛ to 2½ in. diam. The unit incorporates a built-in diamond wheel dresser. Totally enclosed motor is rated ½-hp, 115/230 v, single phase, 3450 rpm. *McDonough Mfg. Co., Eau Claire, Wis.*

Inclinable Presses: Series E single point open back inclinable presses incorporate a front-to-back crankshaft design which makes possible a wide space between gibs. Fully contained box type slide supports wide dies and resists off-center loading. Electropneumatic friction clutch operates directly on the crankshaft. Main gears operate in sealed oil baths. The presses are built in four sizes with capacities from 75 to 200 tons and shaft diameters from 4½ to 7½ in. Fully enclosed motors are 7½, 10, 15 and 20 hp, 1800 rpm. The units are available in both standard and automated models. *Niagara Machine & Tool Works, Buffalo, N. Y.*

Resistance Welder: Weldmatic Model 1016 portable resistance welder is offered with two interchangeable handpieces. It will accommodate metal-foil-backed strain gages developed for welding directly to steels, alloys, aluminum and other materials. For strain gage work, a long-lead handpiece is provided. The welder operates at 115 v ac, with power requirements of 7 amp. Maximum operating speed is 60 welds per minute, continuous duty. In welding stainless steel and resistance alloys, the unit handles sheets from 0.0005 to 0.015-in. thick and wire from 0.0001 to 0.045-in. diam. With copper alloys

RAWSON



4 PURPOSE COUPLING

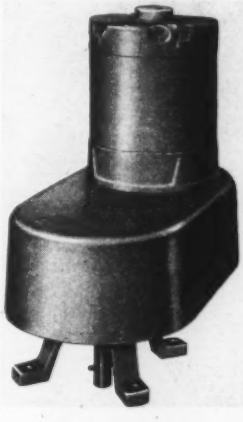
Starts . . . couples . . . cushions . . . limits load

"Rawson" four-duty coupling is an automatic centrifugal clutch consisting of two drum-shaped members—one attached to the driver shaft—and between them two sets of floating shoes made of various friction materials. Simplicity in design and action—the "Rawson" Coupling smoothly transmits the loads between motor and machine in hundreds of varied applications.

RAWSON COUPLING DIVISION

O. S. WALKER CO., INC., Worcester, Massachusetts

—ITEM 284—



New! *Little Giant*

BELT-DRIVEN AGITATOR DRIVE

PROVIDES SLOW, POSITIVE AGITATION OF LIQUIDS WITHOUT CONTAMINATION

Little Giant Belt-Driven Agitator Drive with sealed ball bearings eliminates any possibility of grease or lubricants of any kind dripping into tank.

Available to fit all standard agitators . . . particularly well adapted to the requirements of bulk milk cooler tanks . . . chemical industry . . . soaps and detergents, etc.—wherever liquids must be agitated without a chance of contamination. Output speed from 29 RPM up. The perfect answer for adding more efficiency, economy and trouble-free operation to your liquid agitation application.

FINE PITCH PRECISION GEARS

LITTLE GIANT—the source that combines engineering experience and advanced low-cost production methods to supply quality controlled gears at minimum cost. LITTLE GIANT carefully selects materials to specification . . . produces top quality, high precision and commercial gears with the latest machinery for hobbing, shaping, shaving and generating precision fine-pitch gears from raw material to finished product . . . and maintains precision and quality through rigid inspection procedures after each operation.

SPUR GEARS—up to 12 pitch
HELICAL GEARS—up to 12 pitch
STRAIGHT BEVEL GEARS—up to 16 pitch
WORM & WORM GEARS—any size worm threads ground

WRITE for name of Little Giant Representative nearest you. Little Giant engineers may be able to suggest improvements or economies in your application. Also gear motors and speed reducers.

LITTLE GIANT PRODUCTS, INC. 1600 NORTH ADAMS ST. PEORIA, ILLINOIS

—ITEM 285—

and aluminum it welds sheets from 0.0003 to 0.008-in. thick and wire from 0.0001 to 0.020-in. diam. *Unitek Corp., Pasadena, Calif.*

Floor Drill: Cincinnati 21 in. stationary head floor drill provides power feed as standard equipment in addition to hand lever and handwheel feeds. Four rates of spindle feed from 0.002 to 0.015-in. per revolution are available. A depth gage is provided to disengage feed automatically. The drill uses a No. 4 Morse taper spindle mounted in heavy-duty ball bearings. Eight spindle speeds from 23 to 400 rpm are provided. Motor is rated 1 hp. 60, 50 or 25 cycle. Drilling capacity in cast iron is 1½ in. Overall height of the unit is 88⅜ in. Table diameter is 17 in., vertical table adjustment, 27 5/16 in. *Cincinnati Lathe and Tool Co., Cincinnati, O.*

Portable Tools

Wire Wrapper: Wire-Wrap portable tool makes solderless wrapped electrical connections with solid 14 and 16 gage wire. Powered by an air motor, the tool makes connections in less than one second. Square or rectangular terminals can be made from commonly used metals. Maximum terminal dimensions are 0.132 x 0.132-in. with a minimum 0.375-in. spacing between terminals. Each connection is 11/32-in. long. The tool weighs 2 lb and can be fitted with either a straight or offset pistol-grip handle. An automatic device stops the bit in the correct starting position. Design also includes alloy steel planetary gears with 20 deg pressure angle, positive engagement clutch, and ball bearings on motor spindle and idler gear plate. *Gardner-Denver Co., Keller Tool Div., Grand Haven, Mich.*

Portable Saw: Jet 110 portable traverse saw cuts stone, marble, brick, terrazzo, slate, granite, asbestos products, refractories, structural glass and concrete. Having a wheel diameter of 14 in., it cuts wet or dry to a 5-in. maximum depth on surfaces to 9 ft or more in length. Maximum wheel spindle speed under load is 2000 to 3000 rpm. Saw design incorporates vacuum type cooling system and helical gearing. Motor is rated 15 amp on 25 to 60 cycle, 115 v ac or dc. Planed heavy guide rails are available for permanent setup. Weight of the saw is 83 lb. *Stone Machinery Co., Manlius, N. Y.*

Profiling Tool: Portable Reciprofiler may be used in filing, honing, lapping, polishing, chafing, sawing, milling, grinding and engraving operations. The unit is built on a straight plane, to be held like a hand file. Detachable grip handle is provided. The profiler, driven through a flexible shaft which is rheostat-controlled, rotates and reciprocates simultaneously or independently. Reciprocating stroke adjustable to ⅜-in. can be operated at any speed up to 15,000 strokes per minute. *Nord Corp., Nutley, N. J.*

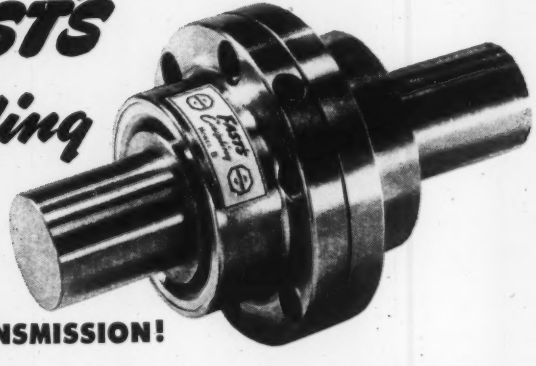
Processing

Tunnel Kiln: Short-period electric tunnel kiln combines green firing and glazing of ceramic materials in one operation. Designed for pilot and small production use, the unit has a total firing time of one hour from loading to unloading. The kiln utilizes silicon carbide elements located over and under the hearth. Operating temperature is 2100 F, and power requirement is 10 kw. All power and temperature controls are mounted and wired in a panel at the base of the kiln. Overall length of the sliding plate type unit is 78 in., and cross-sectional area of the chamber is 10 x 3 in. *Pereny Equipment Co., Columbus, O.*

Glue Applicator: Automatic unit, designed for high production operations, meters and applies thin strips of glue to wood, fiber, paper, textiles, and some processed or synthetic materials. A switch-controlled solenoid opens and closes the rotary glue valve. Applicators are adjustable horizontally for location of glue strips and longitudinally for starting or stopping glue flow. Volume of glue flow is adjustable. Applicators can be arranged side by side for applying multiple lines of glue. Fountains can be equipped with single or double rotary valve units. *Saranac Machine Co., Benton Harbor, Mich.*

The incomparable Model B

FAST'S Coupling



LOW-COST POWER TRANSMISSION!

Designed for light and medium drives—fans, blowers, pumps—a lighter, smaller and lower priced Fast's Coupling! The same famous features found in all Fast's Couplings . . . the same mechanical flexibility, the same positive lubricating principle, the same rugged construction and trouble-free performance . . . the same highly efficient power transmission which has made Fast's Couplings the leader for more than 30 years! Available for shaft sizes up to 2⅝" and sold with Koppers' free engineering service. For the low-cost solution to your shaft coupling problem, write: Koppers Company, Inc., *Fast's Coupling Dept.*, 3501 Scott Street, Baltimore 3, Md.

THE ORIGINAL FAST'S Couplings

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans, Gas Apparatus. *Engineered* Products Sold with *Service*.

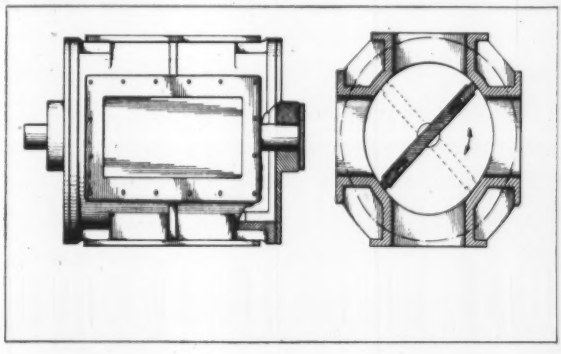
—ITEM 286—

NOTEWORTHY

Patents

Rotary Vane Seal

Leaktight sealing of rotary valve vanes is accomplished by sliding seal elements carried in slots in the rotating vanes. Compression springs force the elements against the fluid chamber wall, maintaining a secure sealing contact and preventing leakage. Both radial and axial sealing are provided by having similar spring-loaded seal elements in the ends as well as



the outer edges of the vanes. Dovetailing the overlapping elements at their corners also assures sealing at the inside corners of the valve chamber. *Patent 2,703,586 assigned to Daly, Merritt & Sullivan Inc. by G. C. F. Asker.*

Light-Duty Sprag Clutch

Thin sheet-metal sprags mounted between concentric raceways on the driving and driven members are utilized to transmit power in a light-duty clutch. V-shaped springs hold the sprags in contact with both raceways for one direction of rotation but permit disengagement when rotation is reversed. *Patent 2,705,066 assigned to Formsprag Co. by L. T. Szady.*

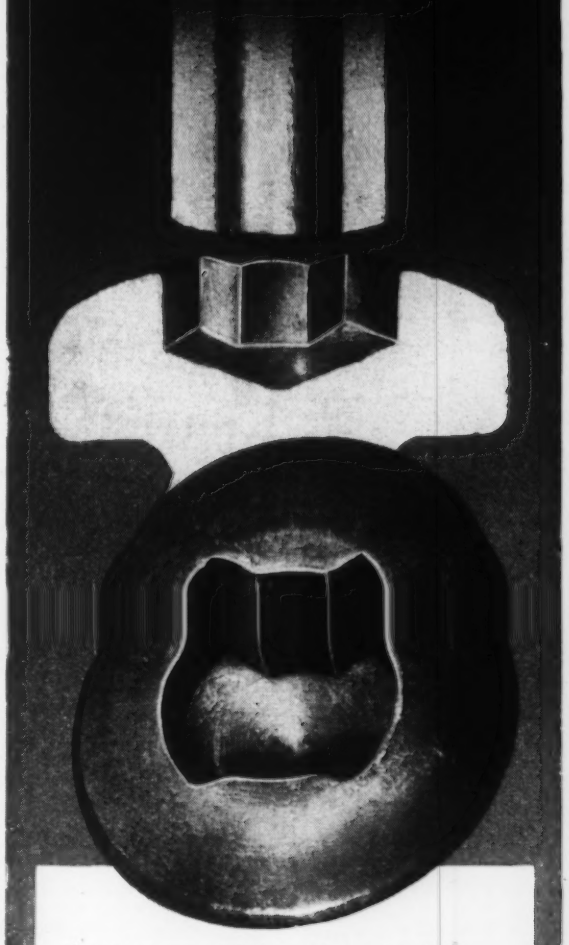
Variable Pressure Seal

By mating a hollow conical rubber diaphragm with a spherically surfaced hub, a shaft seal is formed that operates effectively under varying pressure conditions. At low operating pressures, the normal resilience of the rubber around the shaft makes an effective seal. As pressure is increased, the inside surface of the diaphragm is progressively collapsed against the spherical hub, increasing the effectiveness of sealing engagement and bracing the diaphragm in proportion to the pressure applied. *Patent 2,706,124 assigned to American Meter Co. Inc. by W. J. Koch.*

Low-Friction Shaft Seal

Friction between rotating and stationary steel shoes in a "package" seal construction is minimized by a

UNITED
CLUTCH HEAD®
SCREWS



Driving parallel to the axis of the thread against a straight walled recess, is Clutch Head® screws' claim to superiority over tapered recessed head screws.

—less end pressure
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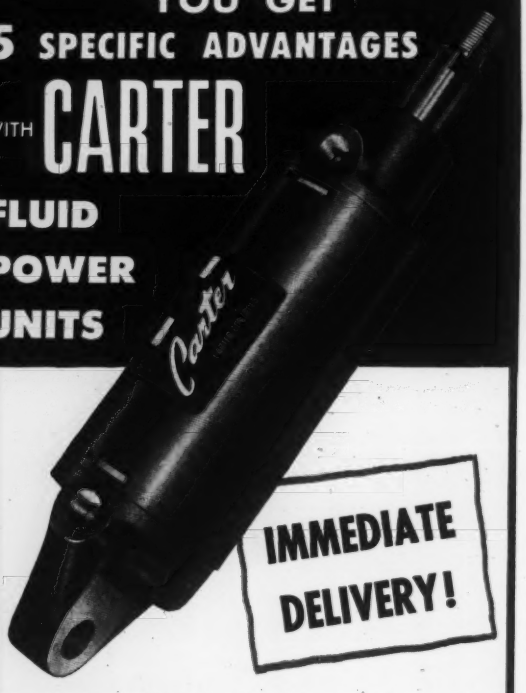
5 SPECIFIC ADVANTAGES
WITH CARTER
FLUID
POWER
UNITS



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1. STRENGTH—DURABILITY—Precision honed heavy wall tubing . . . 10 to 1 safety factor . . . heavy duty, high tensile chrome plated rod as standard. Rugged Carter cylinders give long life, leakproof performance.

2. SIMPLICITY OF DESIGN—Integral cast steel head and mount united with cylinder wall by means of key-type lock ring. Permits 360° orientation of pipe ports. Leakproof "O" ring seal. Design is far ahead of conventional cylinders.

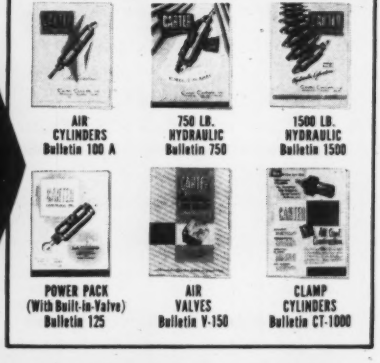
3. EASY MAINTENANCE—Easily disassembled. Cartridge design makes replacement of parts simple, quick. No highly skilled repair help needed. Carter Cartridge Rod Bearing allows on-the-job replacement without disassembly or removal of cylinder from your machine.

4. SPACE SAVING ADVANTAGES—No bolts, no tie rods . . . Carter's compact design of both cylinder and mount saves 40% in space.

5. IMMEDIATE DELIVERY—Standard models available off-shelf. 1½ through 8" bores. Strokes to 18 feet.

SEND FOR THIS COMPLETE BOUND FILE

Complete details with all essential ordering information.


AIR CYLINDERS Bulletin 100 A
750 LB. HYDRAULIC Bulletin 750
1500 LB. HYDRAULIC Bulletin 1500
POWER PACK (With Built-in-Valve) Bulletin 125
AIR VALVES Bulletin V-150
CLAMP CYLINDERS Bulletin CT-1000

CARTER CONTROLS, INC.

2914 BERNICE ROAD • LANSING, ILLINOIS (Chicago Suburb)

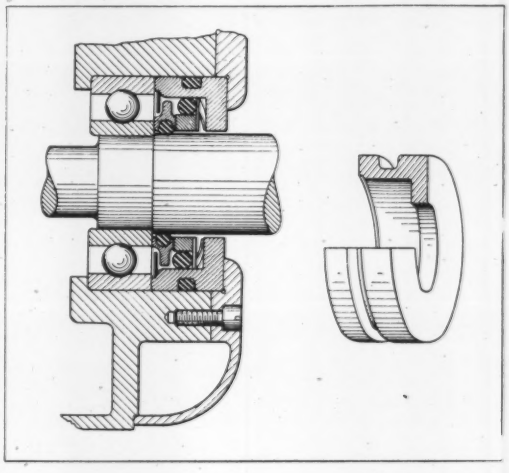
GRanite 4-3305 (Lansing) • BAyport 1-7186 (Chicago)

—ITEM 288—

For More Information Circle Item Number on Yellow Card—page 19

Noteworthy Patents

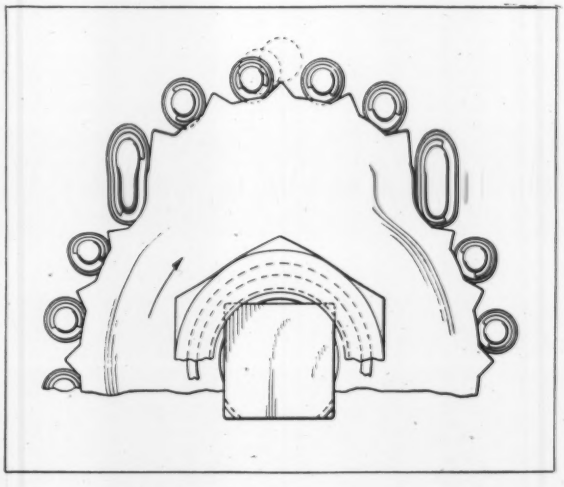
graphite separator ring. Designed for use with anti-friction, or similar bearing applications, the seal design utilizes three O-rings in conjunction with the steel and graphite rings to provide an assembly that



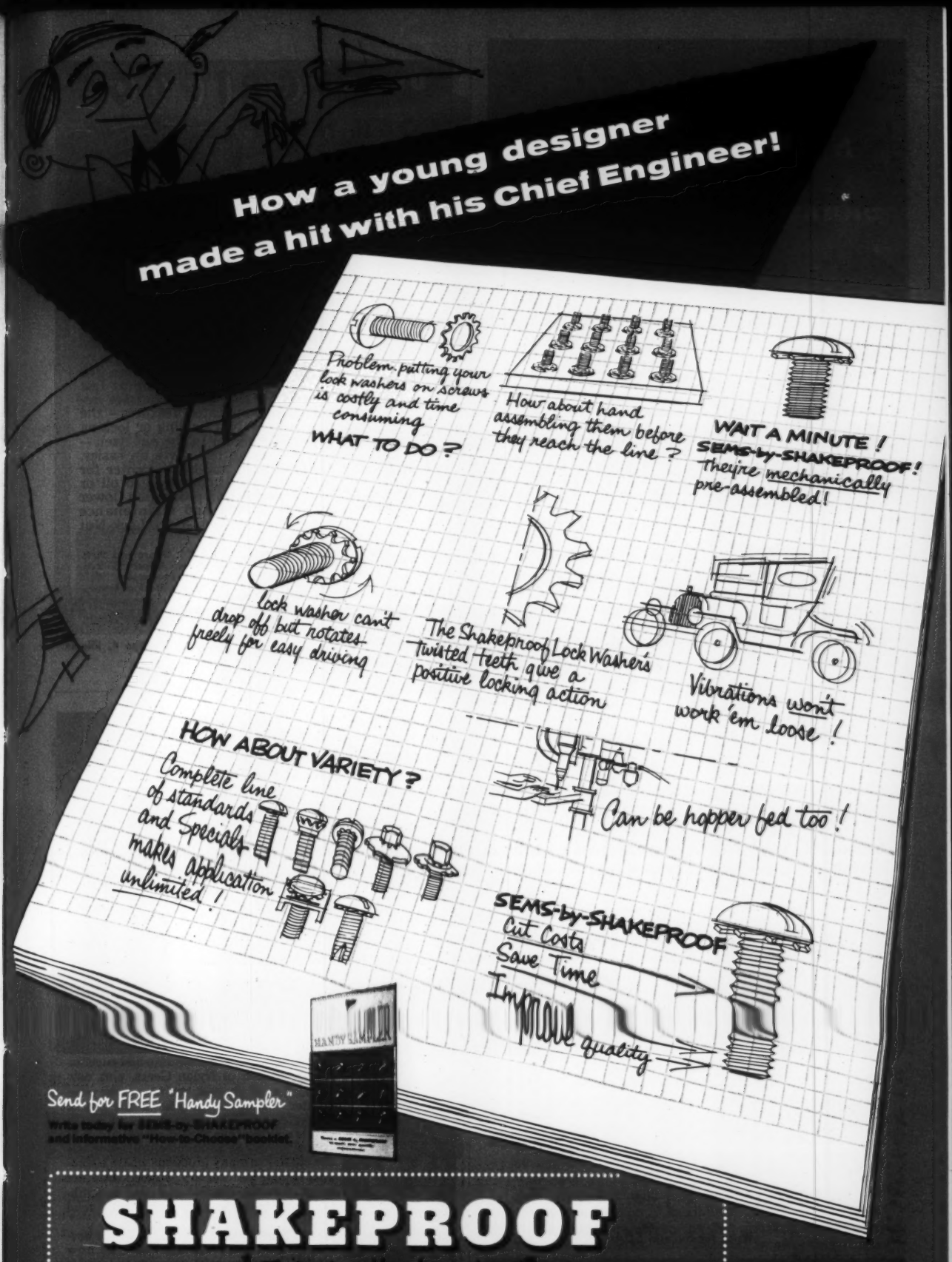
can be mounted or removed as a single unit. A spring washer, used to hold the graphite ring in contact with the rotating steel ring, serves to maintain sealing pressure at the seal faces. *Patent* 2,706,652 *assigned to Master Electric Co. by A. F. Berger.*

Torque Limiting Coupling

Overload in shaft power connections is prevented by a slip coupling design which employs spring-steel rods as power transmission elements. The rods, which are mounted rigidly at one end to a flange on the driving shaft, extend parallel to the axis of the shafts with their free ends resting between sprocket-like teeth on a flange on the driven shaft. Under normal



load, the rods transmit power to the driven shaft through the teeth. If an overload occurs, the rods bend and the free ends ride over the teeth, permitting the coupling to slip. When the load returns to normal, the rods re-engage the teeth to provide a positive shaft connection. *Patent* 2,706,388 *assigned to Borg-Warner Corp. by F. M. Potgieter.*


How a young designer made a hit with his Chief Engineer!
Problem: putting your lock washers on screws is costly and time consuming
WHAT TO DO?
How about hand assembling them before they reach the line?
WAIT A MINUTE! SEMS-by-SHAKEPROOF! They're mechanically pre-assembled!
lock washer can't drop off but rotates freely for easy driving
The Shakeproof Lock Washer's twisted teeth give a positive locking action
Vibrations won't work 'em loose!
HOW ABOUT VARIETY?
Complete line of standards and Specials makes application unlimited!
Can be hopper fed too!
SEMS-by-SHAKEPROOF
Cut Costs
Save Time
Improve quality
Send for FREE "Handy Sampler"
Write today for SEMS-by-SHAKEPROOF and informative "How-to-Choose" booklet.
SHAKEPROOF
"Fastening Headquarters"®
St. Charles Road, Elgin, Illinois • Offices in Principal Cities
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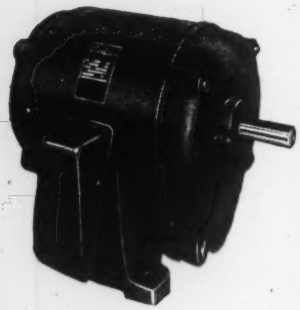
SHAKEPROOF
FASTEX
DIVISIONS OF ILLINOIS TOOL WORKS
World's Greatest Line of Mass-Assembly Fastenings

NEW!
NEMA RERATED FRAME DESIGNS



DRIP-PROOF (Open Type)

• Frame sizes from 56 thru 326. Cast-iron construction. Furnished with ball or sleeve bearings. All exterior surfaces are smooth and symmetrical. Streamlined design affords complete protection against dripping liquids or falling particles.

TOTALLY ENCLOSED NON-VENTILATED

• Totally enclosed, non-ventilated, from ½ to 3 HP. Recommended for use in non-explosive abrasive dust, metal dust, or where foreign matter may enter a motor. Positive protection of motor windings. Same design used with larger motors that drive propeller-type fans where the fan blows cooling air directly over the motor.

TOTALLY ENCLOSED FAN-COOLED

• Totally enclosed, fan-cooled, from ½ to 30 HP. Cooling air is drawn by an external fan across the motor towards the driven machine. Heat generated by the machine is not drawn across the motor. Same system used in standard, fan-cooled motors and explosion-proof designs.

Write for Bulletin SDA-155.

ELECTRIC MOTOR DIVISION

THE Peerless Electric COMPANY

FANS · BLOWERS · MOTORS · ELECTRONIC EQUIPMENT

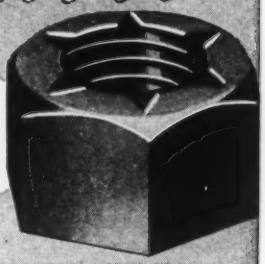
1520 W. MARKET ST. • WARREN, OHIO

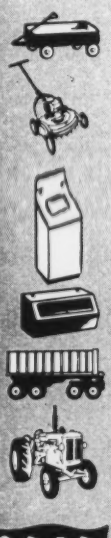
—ITEM 290—

---

use a GRIPCO LOCK NUT

- To Hold Tighter
- To Last Longer
- To Cost Less





in these and hundreds of other applications where stress, wear or vibration is a factor. The Gripco Lock Nut, with its simple, one-piece design, has given industry a tighter, more positive holding action for quicker fastener application at less initial cost. No inserts, outside devices or complicated features – the Gripco Lock Nut holding or locking action is inherent in the nut itself – it costs less to use, gives an easier, faster locking and holds tighter for a longer time. Impervious to oil or water. For faster production, lower manufacturing and maintenance costs, look into the Gripco Lock Nut today.

GRIPCO PRODUCTS INCLUDE: Gripco Lock Nuts, New Gripco "Clinch" Nuts, Gripco Hi-Nuts, Gripco Pilot-Projection and Countersunk Weld Nuts with or without Gripco locking feature.

112

GRIP NUT COMPANY

310-W S. Michigan Avenue, Chicago 4, Illinois

—ITEM 291—

NOW! new economies in NYLON GEARS means savings in gear costs up to 90%

Our many years of pioneering and successful production of Nylon Gears, plus new reduced mold charges, can now make even greater economies for you in the use of Nylon Gears. With the great variety in molds now possible, Nylon should not only be considered as an economy measure but the answer to many problems where a compact design is necessary. Nylon Gears are quiet, durable, efficient and need less lubrication – they mate perfectly with metal gears.

Let our engineers with more than a decade in gear experience show you how Nylon Gears can save you money – let us consider your gear problems during the design process – send blueprints or specs for prompt estimates.

104

PROCESS GEAR CO., INC.

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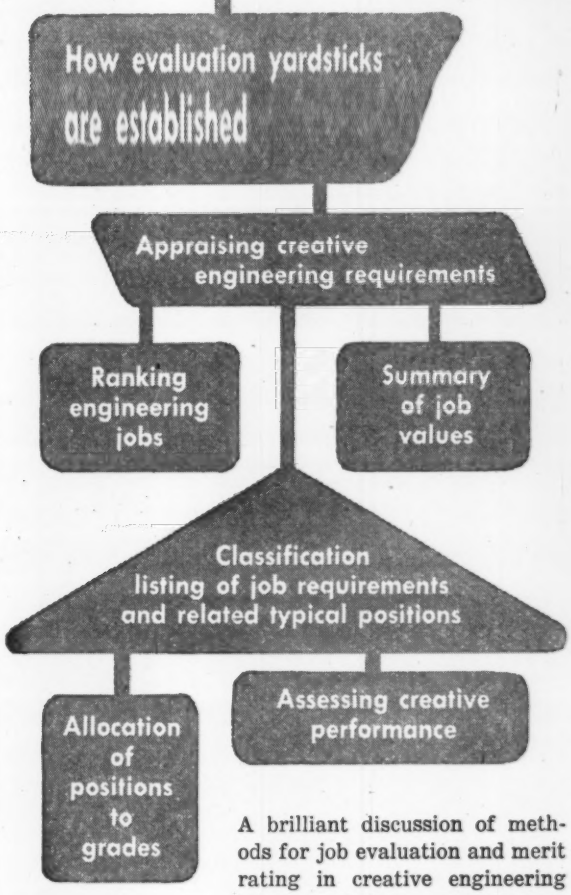
—ITEM 292—

again available

"EVALUATING ENGINEERS"

by Randolph W. Chaffee

. . . to recognize talent and reward achievement


How evaluation yardsticks are established
Appraising creative engineering requirements
Ranking engineering jobs
Summary of job values
Classification listing of job requirements and related typical positions
Allocation of positions to grades
Assessing creative performance

A brilliant discussion of methods for job evaluation and merit rating in creative engineering by one of the country's outstanding authorities in this field. Use the order form below and get your copies while the supply lasts. Remittance with your order will greatly facilitate handling.

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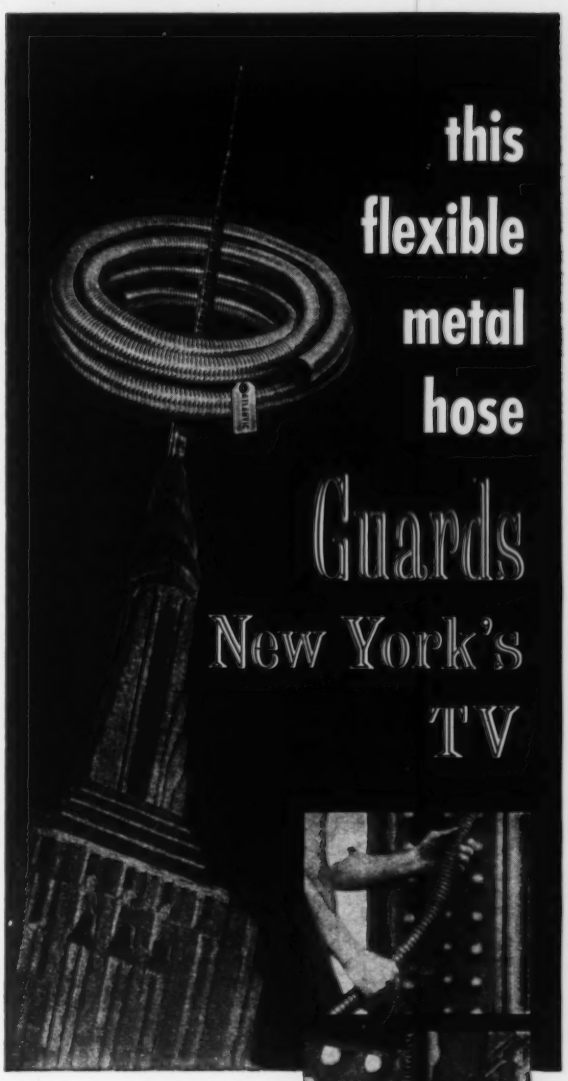


—another example of how Atlantic's engineers and ingenuity devise new solutions to new problems.

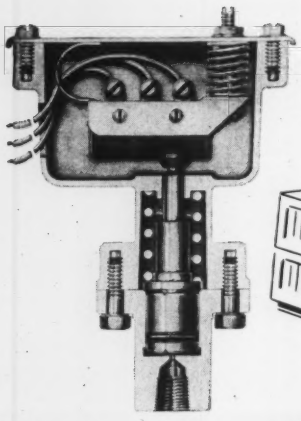
The $1,000,000 tower atop the Empire State building was designed to usher in a new era in TV transmission and reception. Its construction required an unprecedented number of circuits to travel up a tower often of less than two feet square. The conduit, enclosing the cables, had to be extremely *flexible* to avoid splice plates, rivet heads and diagonal braces in the steel work. It had to be permanently weather tight.

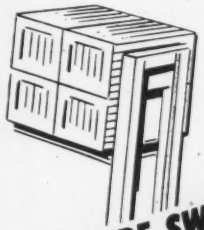
Ordinary rigid and flexible metal conduit failed! Atlantic's engineers in cooperation with the RCA Service Co. designed a heavy duty, high pressure bronze hose that did the job and also saved many costly and hazardous man hours of work. This hose was JOB TESTED and CERTIFIED.

Our engineers will help solve *your* problems in weather protection . . . flexibility . . . conveying . . . controlling pressure, movement and vibration . . . correcting misalignments. Seamless and Interlocking Hose. Bronze, Steel, Stainless Steel, Monel. ⅛"-36" I.D. with proper fittings. Write for Bulletin #500. See our Catalog in Sweet's Product Design File.

ATLANTIC METAL HOSE CO., Inc.
318 DYCKMAN STREET, NEW YORK 34, N.Y.

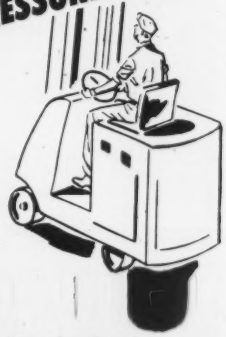
—ITEM 293—





BARKSDALE PISTON PRESSURE SWITCH

Its features in terms of application with the Servis Recorder



In this application the Servis Recorder (with a Barksdale Piston Pressure Switch) is used to check on minimum loads, movements and generally on productive time of fork lift trucks.

FEATURES	APPLICATION
NOT CRITICAL TO VIBRATION and will operate in any position.	This feature is most important to the Servis Recorder in its use on the fork lift where it must function with accuracy under vibration, bumping or shaking.
PROOF PRESSURE TO 7000 PSI and actuation as low as 15 PSI.	Even though the minimum load setting may be relatively low, the surges due to jolts or bumps cannot upset the switch accuracy.
±2% REPEAT ACCURACY because of honed piston bore and direct switch action.	Accuracy is invaluable to the Servis Recorder and the Barksdale switch retains its repeat accuracy, even after long service, because there are no wearing parts to cause the settings to drift.
LONG, LONG SERVICE LIFE They last *millions* of cycles because of simplicity, rugged construction.	The constant cycling in loading and unloading operations day after day makes it imperative for the accuracy of the Servis Recorder that the switch have a long service life.

If these features suggest a solution to your problem, please write for Bulletin 9612.

BARKSDALE VALVES

PRESSURE SWITCH DIVISION

5125 Alcoa Ave., Los Angeles 58, California

—ITEM 294—

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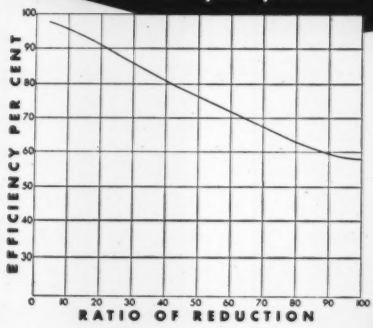
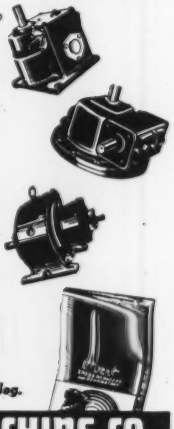
specify *Abart* SPEED REDUCERS for job-proven efficiency



Approximate efficiency curve of *Abart* SINGLE REDUCTION SPEED REDUCERS



The product of specialists—designed and built by experienced power transmission craftsmen—*Abart Speed Reducers* give you the service you want. EFFICIENT, DURABLE, COMPACT and SELF-LUBRICATING—Abart Units are available in 75 sizes: spur, worm and combinations in single and double reduction types: from 1/50 to 168 hp., ratios up to 10,000 to 1.

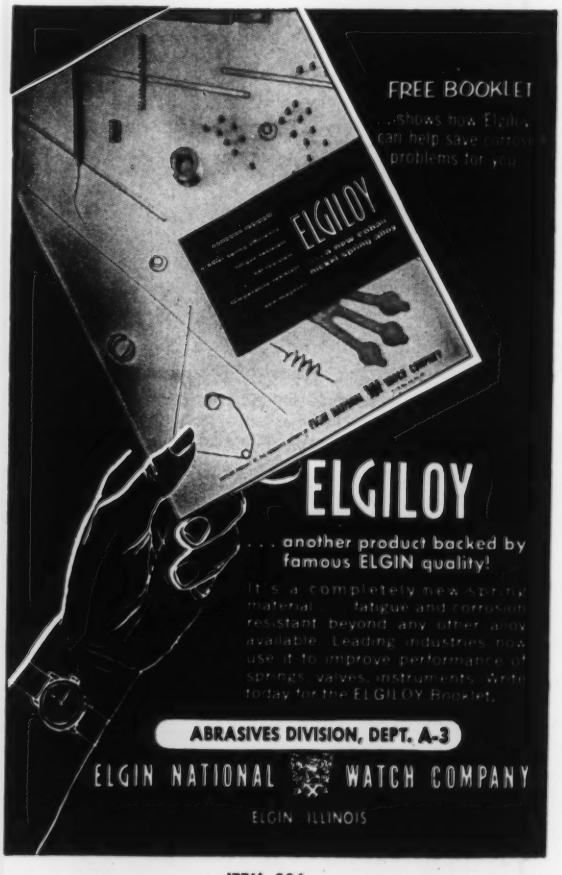
Write today for free data-packed pocket-size catalog.

ABART GEAR and MACHINE CO.

4821 WEST 16th STREET • CHICAGO 50, ILLINOIS

Mfrs. of Gears, Speed Reducers and Gearmotors

—ITEM 295—


FREE BOOKLET
...shows how Elgiloy can help save corrosion problems for you
ELGILOY
ELGILOY
... another product backed by famous ELGIN quality!
It's a completely new spring material ... fatigue and corrosion resistant beyond any other alloy available. Leading industries now use it to improve performance of springs, valves, instruments. Write today for the ELGILOY Booklet.
ABRASIVES DIVISION, DEPT. A-3
ELGIN NATIONAL WATCH COMPANY
ELGIN, ILLINOIS

—ITEM 296—

For More Information Circle Item Number on Yellow Card—page 19

M·F LOCK NUTS

"FEW OLDER IN EXPERIENCE— NONE YOUNGER IN FACILITIES AND DESIGN."

THIS IS THE M-F *Uni-Torque*

- A seasoned organization—
- Using the most modern facilities from laboratory to tool room to production machinery . . .
- Has developed techniques and methods which create in a simple low-cost product—
- *Reliability of torque never before thought possible.*
- Try the M-F Uni-Torque for yourself.

NO SLOTS
NO FIBRE
NO PLASTIC
NO EXCESS COST!

Mac Lean-Fogg Lock Nut Company
5535 North Wolcott Avenue, Chicago 40, Illinois

—ITEM 297—

That vital "ounce of protection" that pays...
BIG DIVIDENDS

S. Silbhite
Plastic Shipping PLUGS and CAPS

Low-cost protection against-

- Dirt, dust and moisture
- Thread damage
- Loss of liquids

C-2

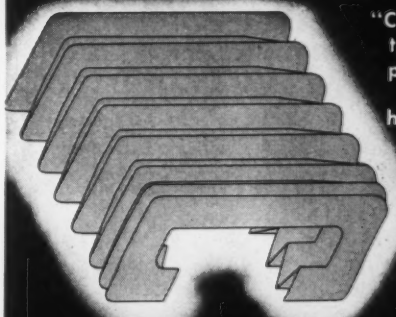
Here's convenient, inexpensive protection against handling and shipping damage. Used to cover threaded openings and connections, these protective plastic plugs and caps repay their low cost many times over by eliminating unnecessary service and repair work and by reducing customer complaints. They're available for immediate delivery in a wide range of sizes in both threaded and plain types.

Bulletins P-5312 and P-5203 have full details. Write for copies. Dept. 4P.

THE S. Silbhite PLASTICS DIVISION
DENTAL MFG. CO.
10 East 40th Street
New York 16, N.Y.
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

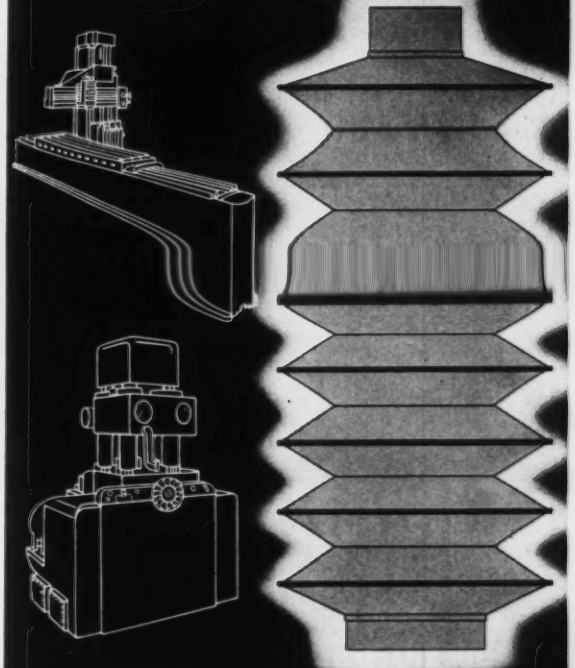
—ITEM 298—

PROTECTED



"C" and "L" type way protectors for horizontal use.

Accordion pliable sleeves for vertical applications.



GORTITE

1 or 1000 without mold charge!

ALL SHAPES AND CONTOURS

Many shapes and contours, like these shown here, are described in a NEW bulletin SPC-2: Zippers and special, duPont coatings extend the range of usefulness for dirt exclusion and lubricant retention. Fabricated from duPont (neoprene-base) materials GORTITE parts last from 3 to 5 times longer than molded rubber. For bulletins, layouts, designs and estimates write or wire to—

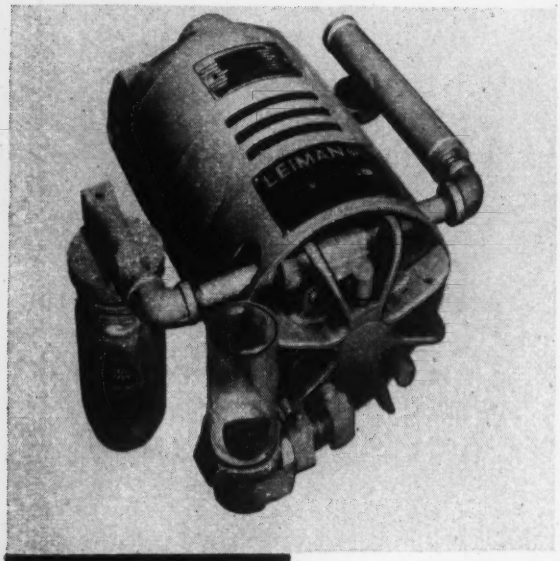
A&A Mfg. Company Inc.
2017 W. Clybourn St. • Milwaukee 3, Wis.

—ITEM 299—

Small Size Air Pump with "Big Time" Features!

LARGE VOLUME!

Saves space—reduces costs—eliminates trouble—improves performance



LEIMAN

INTEGRAL ROTARY AIR PUMP and MOTOR

28 Hg. Continuous Vacuum
20 lbs. Pressure

MODEL K
3.6 c.f.m. ⅓ hp.
13½" long—12" wide
7" high

MODEL K-3
7.2 c.f.m. ½ hp.
16" long—15" wide
9" high

- Steel wings for long wear
- Automatic Wing Adjuster prevents wing sticking
- Automatic oiler — requires filling only once in 60 to 80 hours.
- Ball bearings for quiet running
- Fan cooled—may be run 24 hours a day, 7 days a week
- Automatic thermal overload protection for motor
- Noiseless
- Inlet filter and outlet separator
- Oil-free air

Write for folder and prices giving full details.
Also get 16-page catalog showing other types and sizes.

LEIMAN BROS., Inc.
148 Christie St., Newark 5, New Jersey

SEE OUR CATALOG IN SWEET'S FILE

—ITEM 300—

Here's BIG HELP IN TERMINAL WIRING!

The correct wire to correct terminal every time!

The New JONES FANNING STRIP

Connections are made through Fanning Strip, on bench or anywhere apart from barrier strip, and quickly slipped into assembly.

Designed for use with Jones Barrier Terminal Strips Nos. 141 and 142, for 1 to 20 terminals.

9-141 Barrier Strip

Simplifies and facilitates soldering. Insures positive correct connections. Saves time. Ideal for harness or cable assembly. Strong construction: Brass terminals, cadmium plated. Heavy bakelite mounting.

9-161 Fanning Strip. Pat. applied for.

Send for complete data on this new basic improvement!

Jones

HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED CARR FASTENER CORP.

—ITEM 301—

"MECHANICAL SPRINGS"

by A. M. Wahl

THOROUGH DISCUSSION OF FUNDAMENTAL PRINCIPLES . . . PRACTICAL FORMULAS FOR DESIGN . . . AUTHORITATIVE INFORMATION ON SPRING APPLICATIONS . . . IN 435 PAGES FULLY ILLUSTRATED WITH DETAILED DRAWINGS.

Thousands of design engineers have discovered "MECHANICAL SPRINGS" by A. M. Wahl . . . it has become a practical aid to spring design in hundreds of design libraries.

It contains the kind of information that enables preliminary calculations to be made on the design of all types of springs: helical, disk, Belleville, flat, leaf, torsion, spiral and volute.

And no matter what your problem . . . working stress . . . fatigue . . . buckling . . . or just plain maximum efficiency, you will find that "MECHANICAL SPRINGS" can reduce the "guesswork" as well as save you time and materials.

Use the form below and get yours today!

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Send me____copies of "MECHANICAL SPRINGS" at $6.00 per copy.
☐ Remittance enclosed in which case book will be sent postpaid
☐ Please bill me ☐ C. O. D.

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE ____ STATE _____
(Add 3% to orders for delivery in Ohio to cover State Sales Tax.)

MECHANICAL DESIGN ENGINEERS

Earthmoving experience, with successful record in design and development of heavy mechanical equipment, crawler tractors, bulldozers, winches and attachments.

Work includes layout and design of heavy machinery for construction and mining.

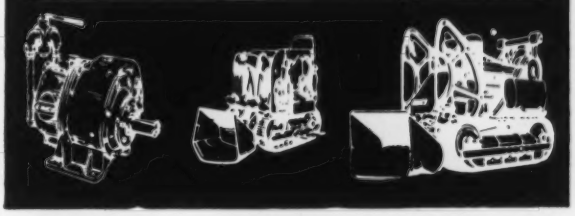
Permanent positions open, for those qualified, with one of the nation's fastest growing heavy machinery manufacturers.

Location—Salt Lake City, Utah—in the mountain West, where you can breathe clean air, and drive from home to work in less than 20 minutes.

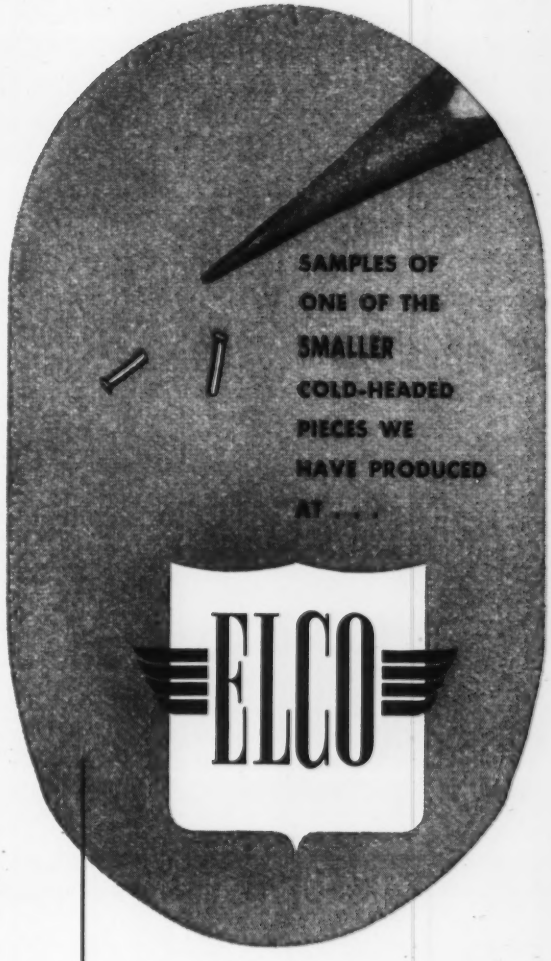
Send complete information and photograph to:

The EIMCO Corporation

P. O. Box 300 **Salt Lake City 10, Utah**



—ITEM 302—



"ELCO SCREWS ARE GOOD SCREWS
...ASK A MAN WHO HAS USED THEM"

- WOOD SCREWS
- MACHINE SCREWS
- MACHINE SCREW NUTS
- TAPPING SCREWS
- THREAD-CUTTING SCREWS
- PHILLIPS AND SEMS SCREWS
- PIPE PLUGS
- STOVE BOLTS
- CAP SCREWS
- LAG SCREWS
- DRIVE SCREWS
- SPECIAL SCREWS
- COLD HEADED PRODUCTS

ELCO TOOL AND SCREW CORPORATION

1950 BROADWAY, ROCKFORD, ILLINOIS

—ITEM 304—

push-pull CONTROLS

Compression & Tension Type

Aircraft cable is strung with spherical steel shells in a rigid or flexible housing sealed with "O" rings. 3" standard bend radius. ¾" minimum bend radius.

Three Types:

1. ***Light Duty***—Compression Ult. Load 1250 lbs.; Ult. tension 960 lbs.
2. ***Heavy Duty***—Compression Ult. Load 1650 lbs.; Ult. tension 960 lbs.
3. ***Extra Heavy Duty***—Compression Ult. Load 3050 lbs.; Ult. tension 3900 lbs.

Modernize your push-pull control system with Southwest Mechanical Push-Pull Controls. Eliminate bell cranks, pulleys, and dual cables. Send for ENGINEERING MANUAL giving detailed prints and complete specifications covering materials, finishes, capacities. Please address Dept. MD-56.

SOUTHWEST PRODUCTS CO.
1705 So. Mountain Ave., Duarte (Los Angeles County), Calif.

—ITEM 303—

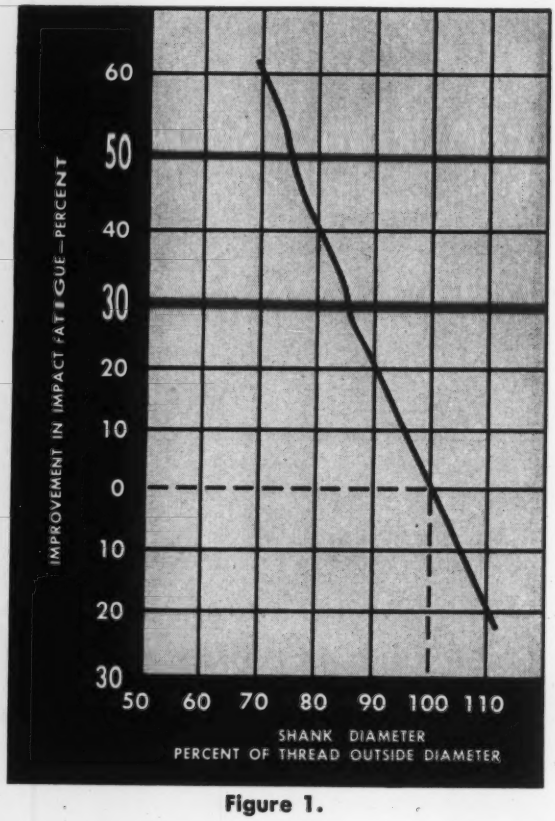


Figure 1.

FATIGUE STRENGTH is improved when SHANK DIAMETER of the BOLT becomes less than the O. D. of the THREAD

Figure 1, page 4 in the Engineering Section of our catalog—"Fatigue Strength is improved when the shank diameter of the bolt becomes less than the O.D. of the thread," is just one of the several factors that are discussed, on pages 3, 4, 5, and 6, in the applications of finished hexagon nuts, where highly stressed bolts of special material are required. . . . Fourteen topics, concerning the technique in the manufacture and proper installation of our product are covered in this twenty-four page brochure—requests for this literature will be handled promptly.

NATIONAL MACHINE PRODUCTS COMPANY

Manufacturer of Standard and Special 12 Pointer and Hexagon Nuts . . . "Huglock" and "Marsden" locknuts.*

44255 Utica Rd., UTICA, Michigan

—ITEM 305—

MAYLINE

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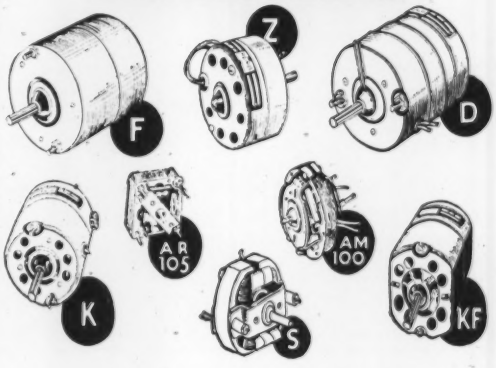

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All described in the Heinze catalog.

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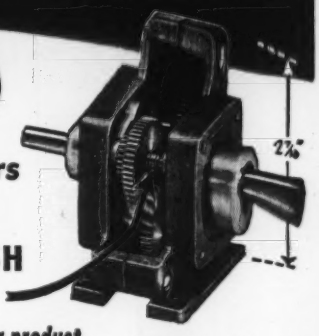
Metron

Bantam Speed Reducers with ANTI-BACKLASH FEATURE



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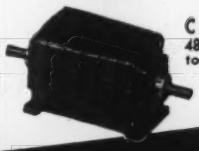

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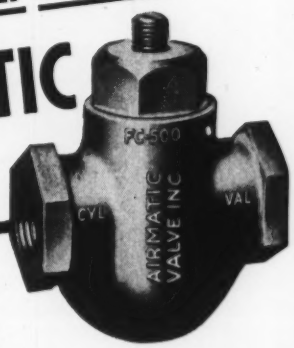

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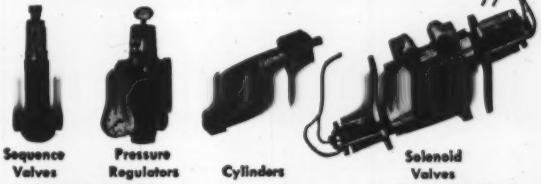

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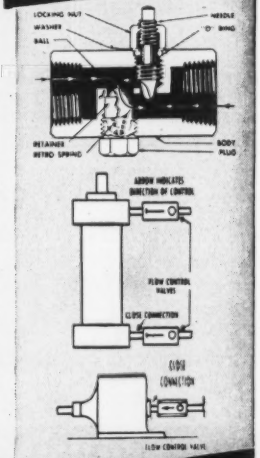

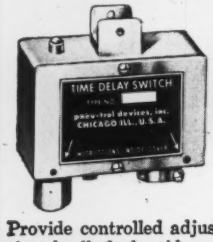

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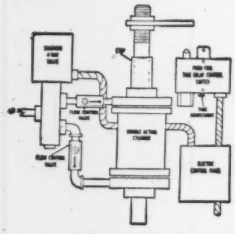

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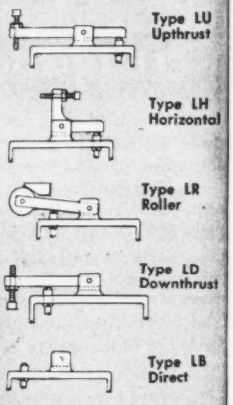

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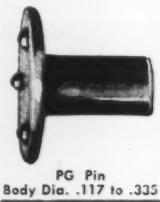
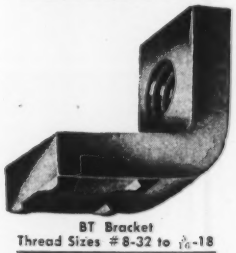


PG Pin
Body Dia. .117 to .335



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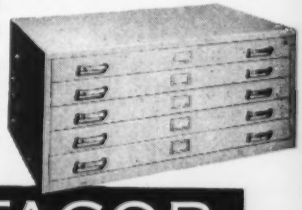

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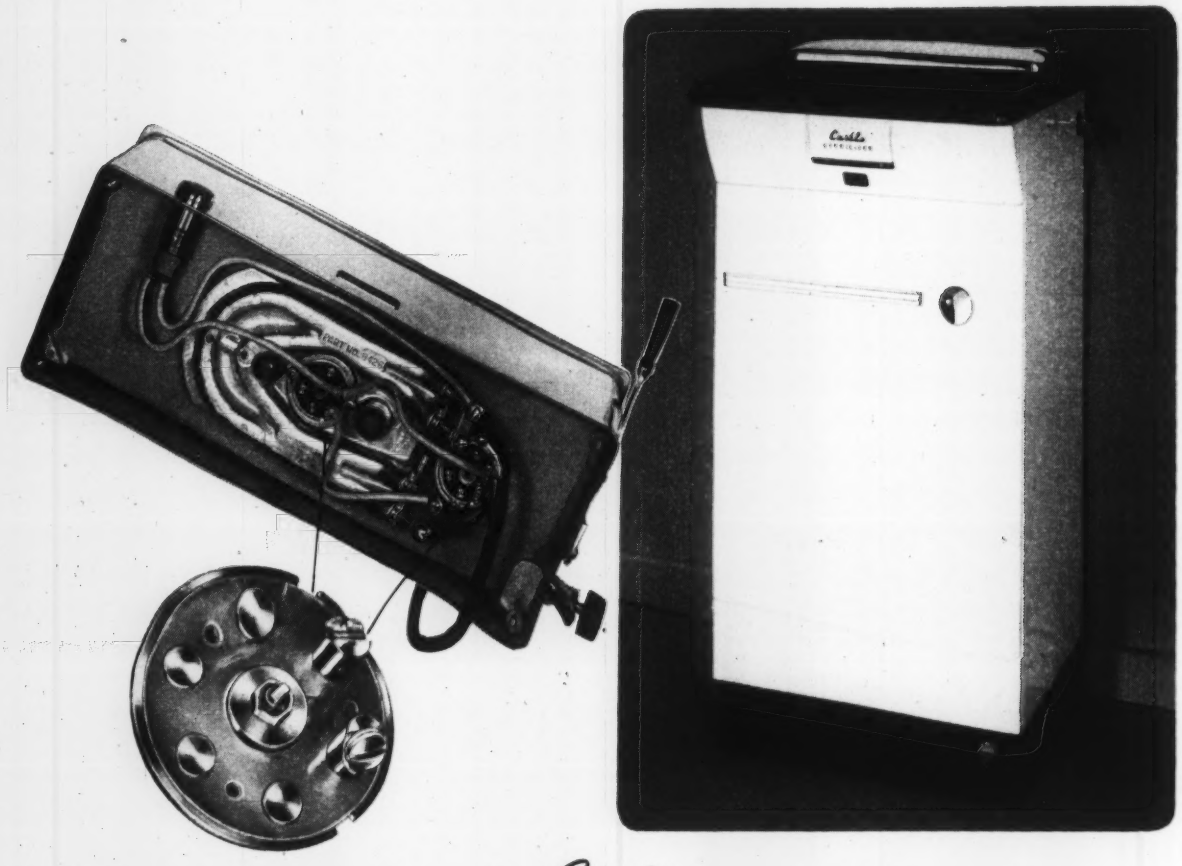

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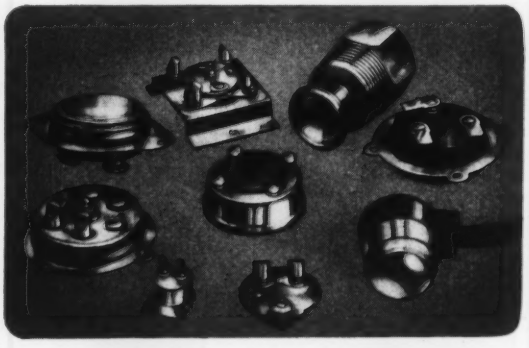

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SPENCER THERMOSTAT DIVISION
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Parts are made to fit size, shape and tolerance specifications *precisely,* and are mass-produced in quantities of 100,000 to many millions. *Smallness* is unlimited: Maximum weight, ½ oz., maximum length, 1¾ inches.

MODERN UP-TO-DATE GRIES PLANT OFFERS COMPLETE FACILITIES

The modern Gries plant in Westchester County, New York, provides large scale production facilities for small precision parts. It offers complete tooling and design equipment, as well as facilities for secondary operations such as tapping, drilling, assembling, reaming and special machining.

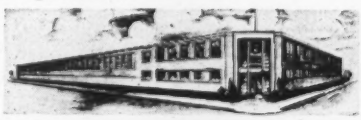
Practically all commercial finishes for zinc alloy die castings can be applied. Gries' many years of experience in finishing small die castings provides highest quality finishes at lowest cost.

GRIES OFFERS FACT-FILLED INFORMATIVE DIE CASTING BULLETIN

Gries offers a factual bulletin containing charts of approximate dimensional and weight limits, comparisons of the GRC die casting method with other methods, composition and properties of zinc alloys for die castings as well as illustrations of many typical small parts and design engineers' guide for reference in designing products that use small parts.

WRITE, WIRE OR PHONE TODAY

for your copy of the Gries Die Casting Bulletin. Find out how Gries can help you solve your parts problems—economically and efficiently. Send prints for quotations.



GRIES STAFF OF ENGINEERS AVAILABLE FOR CONSULTATION

GRC maintains a staff of experienced engineers to aid manufacturers on all phases of design production. They will design production dies that best utilize the special machines and processes that have been developed by Gries over a period of 40 years. Gries engineers are available for consultation at any time.

GRIES OFFERS MANY OTHER PRODUCTS AND SERVICES

Gries can furnish many zinc alloy products directly from stock—including die cast industrial fasteners, and has facilities for the precision molding of tiny plastic parts. If you are interested in any of these other products and services, write direct for specific information.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.

32 Second Avenue, New Rochelle, N. Y. NEw Rochelle 3-8600

—ITEM 317—

Two types of Krueger and Hudepohl clips, and strips showing progressive stages in fabrication.

Spring quality of REVERE PHOSPHOR BRONZE makes solderless connections possible

It is not always the case that solder has to be used to make good electrical connections. Often phosphor bronze clips can be used, tightness being achieved through the hard-gripping spring quality of this metal. Take the clips made by Krueger and Hudepohl, Inc., Cincinnati 2, Ohio. This company uses Grade A 5% Revere Phosphor Bronze to make its connections for refrigerators, and for submersible pumps and hydraulic control units. Such services require not only tight permanent connections, but the ability to withstand severe temperature variations, as well as vibration. Revere Phosphor Bronze meets the needs perfectly. In developing this application, the Revere Technical Advisory Service collaborated closely with the customer on the important matter of temper required both for fabrication and end use. Krueger and Hudepohl report no rejects. The metal is supplied in the form of strip, one inch wide, and in very long coils, so that down time for coil set-up on each progressive die machine is minimized. Send for your free copy of "Revere Phosphor Bronze," which provides details about qualities, performance, and applications.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

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Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere.

"The Revere Four-Way Service" is a 16mm sound motion picture in color, interesting and informative. If you would like to see it, write nearest Revere Sales Office.

—ITEM 318—

Lubrication is automatic on Sundstrand's "Engineered Production" machine tools

FARVAL—
Studies in Centralized Lubrication
No. 182

The idea behind Sundstrand "Engineered Production" Service makes sense: Manufacturer and Sundstrand Engineers work closely together to find the best processing method for the job at hand. The result is the same as you experience with a custom-tailored suit—it fits.

FARVAL fits Sundstrand pattern

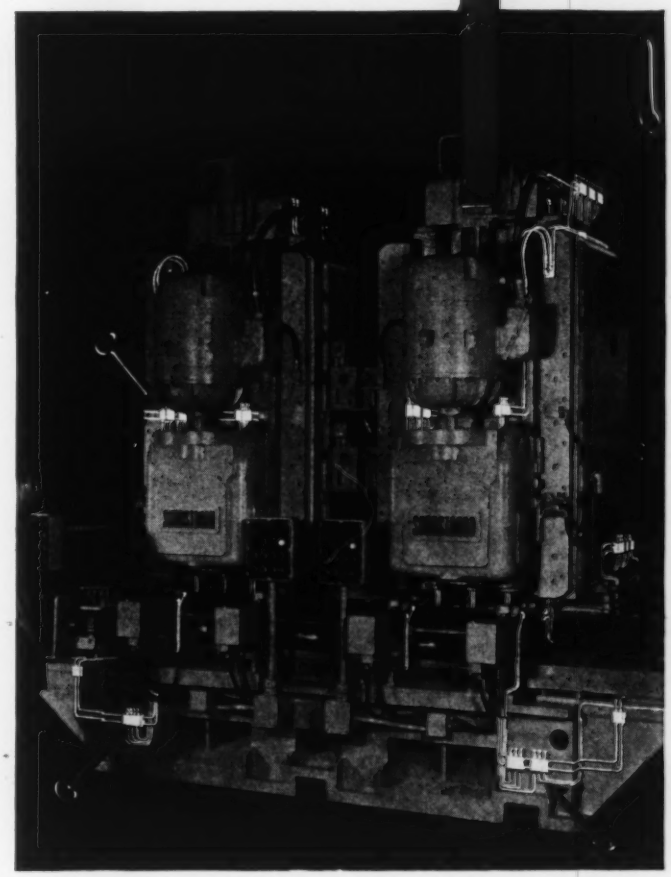
Farval Centralized Systems of Lubrication, like Sundstrand Machine Tools, are engineered for the job. Where there are bearings to be lubricated, Farval will make sure the job is done correctly. That's why Sundstrand chooses Farval—and why other machine-tool specialists are doing likewise.

It works like this: As *the* Dualine system of centralized lubrication, Farval delivers a measured amount of clean lubricant at regular intervals to *every* bearing in the Farval circuit. From a centrally located pump and reservoir, lubricant is pumped under pressure, to a measuring valve at each bearing. The exact amount of lubricant required by the bearing is delivered to it. And, indicators at every bearing show *positive proof* that each valve has functioned.

Let Farval help you

Lubrication problems that seem tough for you are a cinch for Farval. One of our lubrication engineers will be glad to inspect your plant and present a written analysis of what Farval can do for you. This service is without obligation, of course. If you'd like the complete Farval story, just write for Bulletin 26-R. The Farval Corporation, 3287 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Co., Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



This is a Sundstrand two station rough boring unit for 6 cylinder engine blocks.

KEYS TO ADEQUATE LUBRICATION—**Wherever you see these Farval valve manifolds, dual lubricant lines and central pumping station, you know a machine is being properly lubricated.**